

PROJECT MANUAL

Connor Building,
39 King Rd.,
Richmond Hill

ISSUED FOR TENDER

WSP Project No. CA0010351.5022

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APPENDICIES

Appendix A – CoRH Guideline: Door Hardware & Key Specifications for the Connor Building

Appendix B - CoRH Guideline: Card Access System Specifications for the Connor Building

Appendix C - CoRH Guideline: Surveillance system specifications for the Connor Building

Appendix D - CoRH Guideline: Burglary Intrusion System Specifications for the Connor Building

Appendix E – WSP Canada Inc.: Arborist Report, Dated - March 21, 2025

Appendix F1 – Haag Canada: Summary of Asbestos-Containing Materials at Connor Building, Dated Dec. 13, 2021

Appendix F2 – WSP Canada Inc.: Asbestos Sampling Assessment Report, Dated – February 9, 2023

Appendix G-1 – Soil Engineers Ltd.: A Geotechnical Investigation for Proposed Building Redevelopment - Dated May 2023

Appendix G-2 – Soil Engineers Ltd.: Soil Characterization Report - Dated – Rev. March 17, 2025.

Part-1 GENERAL

- 1.1 The requirements of the Articles of Agreement, Conditions of the Contract, Division 1 apply to and form all Sections of the Contract Documents and the Work.
- 1.2 Work in this Specification is divided into descriptive sections which are not intended to identify absolute contractual limits between Subcontractors, nor between the Contractor and their Subcontractors. The Contractor is responsible for organizing division of labour and supply of materials essential to complete the Contract. The Consultant assumes no liability to act as an arbiter to establish subcontract limits between Sections or Divisions of Work.
- 1.3 It is intended that Work supplied under these Contract Documents shall be complete and fully operational in every detail for the purpose required. Provide all items, articles, materials, services and incidentals, whether expressly specified or shown on Drawings, to make finished Work complete and fully operational, consistent with the intent of the Contract Documents.
- 1.4 Work designated as “N.I.C.” is not included in this Contract.
- 1.5 Specifications, Schedules and Drawings are complementary and items mentioned or indicated on one may not be mentioned or indicated on the others.
- 1.6 Contractors finding discrepancies or ambiguities in, or omissions from the Drawings, Specifications or other Contract Documents, or having doubt as to the meaning and intent of any part thereof shall contact the Consultant for clarification.
- 1.7 Mention in the specifications or indication on the drawings of materials, products, operations, or methods, requires that the Contractor provide each item mentioned or indicated of the quality or subject to the qualifications noted; perform according to the conditions stated in each operation prescribed; and provide labour, materials, Products, equipment and services to complete the Work.
- 1.8 Where the singular or masculine is used in the Contract Documents, it shall be read and construed as if the plural, feminine or neuter had been used when the context or the statement so requires and as required to complete the Work, and the rest of the sentence, clause, paragraph, or Article shall be construed as if all changes in grammar, gender or terminology thereby rendered necessary had been made.
- 1.9 The terms “approved”, “review”, “reviewed”, “accepted”, “acceptance”, “acceptable”, “satisfactory”, “selected”, “directed”, “instructed”, “required”, “submit”, “permitted”, “approved alternative”, “approved equal”, or similar words or phrases are used in standards or elsewhere in Contract Documents, it shall be understood, that words “by (to) the Consultant” follow, unless context provides otherwise.
- 1.10 Where the words 'submit', 'acceptable' and 'satisfactory' are used in the Contract Documents, they shall be considered to be followed by the words 'to the Consultant' unless the context provides otherwise.
- 1.11 The terms “exposed” or “exposed to view” refers to surfaces that are within the line of vision of persons from any accessible viewpoint, both within and without the building. Where any part

of a surface is exposed to view, all other portions of that surface shall also be considered as exposed to view.

2 EXISTING SITE CONDITIONS

- 2.1 Make a careful examination of the site, and investigate and be satisfied as to all matters relating to the nature of the Work to be undertaken, as to the means of access and egress thereto and therefrom, as to the obstacles to be met with, as to the extent of the Work to be performed, any limitations under which the work has to be executed, and any and all matters which are referred to in the Contract Documents. 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.
- 2.2 Report any inconsistencies, ambiguities, discrepancies, omissions, and errors between Site conditions and Contract Documents to the Consultant prior to the commencement of Work. If inconsistencies, ambiguities, discrepancies, omissions, and errors are not reported and clarified, the most stringent requirement shall govern, as determined by the Consultant. Ensure that each Subcontractor performing work related to the site conditions has examined it so that all are fully informed on all particulars which affect the Work thereon in order that construction proceeds competently and expeditiously.
- 2.3 Before commencing the Work of any Section or trade, carefully examine the Work of other Sections and trades upon which it may depend, examine substrate surfaces, and report in writing to the Consultant, defects which might affect new Work. Commencement of Work shall constitute acceptance of conditions and Work of other sections, trades, and Other Contractors upon which the new Work depends. If repair of surfaces is required after commencement of specific work it shall be included in the work of the trade providing the specific system or finish.

3 CONTINUITY OF EXISTING SERVICES

- 3.1 Shutdowns and planning of operations that may affect Owner's use of services shall be coordinated with and in accordance with the Owner's written directions. Provide notice for all required interruptions to utility, heating, cooling, mechanical, electrical, and life safety systems.
- 3.2 Make written requests for shutdown at least 5 working days in advance, unless specifically stated herein or as otherwise instructed by the Owner.
- 3.3 Shutdowns shall be scheduled in advance with Owner and shutdown period shall be minimized to Owner's convenience. Facilities in existing adjacent areas will be occupied during the Work.
- 3.4 Major shutdowns shall take place on weekends or at night by prior arrangement with and at no additional cost to the Owner.
- 3.5 Minimize disruption, vibration, noise and dust to the function of existing building.
- 3.6 These requirements are for security reasons and for the consideration of the Owner. Requirements shall not be construed as cause for elimination or restriction of Contractor's working schedule, claims for delay or work, nor additional cost.

4 ACCESS/PROPERTY CONSTRAINTS

- 4.1 Perform Work only during the following times unless otherwise approved by the Owner:
 - .1 7am to 7pm, Monday to Friday.
- 4.2 Provide and maintain access facilities as may be required for access to the Work.
- 4.3 Minimize disruption, noise and dust to the functions of existing operational areas of existing buildings. Times of entry, routes of access and time required to complete the Work shall be arranged and scheduled in cooperation with the Owner.
- 4.4 Confine Work and operations of employees to limits indicated by the Contract Documents. Do not unreasonably encumber the premises with products.
- 4.5 Organize delivery of materials/equipment to and removal of debris and equipment from place of Work to permit continual progress of work and suitable for restricted site conditions.
- 4.6 Determine and make arrangement as required for loading and unloading of equipment and Products at times that will not affect public traffic flow and that will be permitted by the City of Richmond Hill. Conform to City by-laws with regard to parking restrictions and other conditions.
- 4.7 Make provisions and arrangements and provide allowances if times for loading and unloading allowed by the City of Richmond Hill are other than regular working hours.
- 4.8 All Products, materials and equipment required on Site shall be portable and/or size suitable for access and movement on Site and without causing damage to buildings.
- 4.9 Workers shall not enter existing building beyond construction areas except where required for connection or modification to existing services or other such work. Arrange such requirements with Owner prior to entering existing occupied areas.
- 4.10 Provide locked doors in barriers, permit access by Owner and Consultant to Work areas and to areas Contractor is responsible for.
- 4.11 Personnel access and material deliveries to the Site shall be only by routes designated by the Owner. Deliveries are to be made between 8:30am and 4:30 pm and must be received on site by Contractor staff on the day of delivery. City staff will not receive or accept responsibility for delivery of products on behalf of the contractor if contracting staff are not on site. Owner's equipment such as trucks, bins, dollies, and other such equipment/facilities shall not be used by Contractors. Arrangements for handling items weighty or bulky enough to require special treatment must be made and reviewed with the Owner.
- 4.12 Advise the Owner 48 hours in advance of large or cumbersome item deliveries. Give particulars of item size and weight, protection to existing surfaces to be provided and safety precautions during movement.

5 SETTING OUT

- 5.1 Before commencing work, verify lines, levels and dimensions shown on the drawing and report discrepancies in levels or dimensions to the Consultant. Be responsible for work done prior to the receipt of the Consultant's decision regarding reported discrepancies.

6 CASH ALLOWANCES

- 6.1 Allowances included are for items of Work which could not be fully quantified prior to Bidding.
- 6.2 Refer to City of Richmond Hill General Conditions regarding cash allowances and list of Cash Allowances on Bid Form.

7 PARKING

- 7.1 Parking will be permitted on Site provided it does not disrupt the performance of Work, Site safety or the movement of vehicular or pedestrian traffic and is acceptable to the Consultant.

8 COORDINATION

- 8.1 Coordination of the Work of all Sections of the specifications as required to complete the Project is the responsibility of the Contractor.
- 8.2 Coordinate with removals/installations specified in other Divisions and Other Contracts.
- 8.3 Existing equipment shall remain in present locations unless designated otherwise. Protect from damage. Remove, store and reinstall existing fixed equipment, fixtures and components which interfere with construction and which are scheduled for relocation.
- 8.4 Where supports or openings are to be left for the installation of various parts of the Work furnish the necessary information to those concerned in ample time so that proper provision can be made for such items. Cutting, drilling and the subsequent patching required for failing to comply with this requirement shall be performed later at no additional Cost to Owner.
- 8.5 Ensure that setting drawings, templates, and all other information necessary for the location and installation of materials, fixtures, equipment, holes, sleeves, inserts, anchors, accessories, fastenings, connections, and access panels are provided by each Section whose work requires cooperative location and installation by other Sections, and that such information is communicated to the applicable installer. Cutting, fixing and 'making good' of the work of other Contractors, Subcontractors and trades and making up of lost time involved in failing to comply with this requirement shall be performed at no additional Cost to Owner.
- 8.6 Be responsible for coordinating products supplied in metric (SI) and imperial units into the overall layout.
- 8.7 Properly coordinate the work of the various Sections and trades, considering the existing installations to assure the best arrangement of pipes, conduits, ducts and mechanical, electrical and other equipment, in the available space. Under no circumstances will any extra payment be allowed due to the failure by the Contractor to coordinate the Work. If required, in critical

locations, prepare interference and/or installation drawings showing the work of the various Sections as well as the existing installation, and submit these drawings to the Consultant for review before the commencement of Work.

- 8.8 Coordinate with mechanical and electrical trades to ensure protecting, supporting, disconnecting, cutting off, capping, diverting, relocating or removing of existing services in areas of Work before commencement of alteration work.
- 8.9 In case of damage to active services or utilities, notify Consultant and respective authorities immediately and make all required repairs under direction of Consultant and respective authorities. Carry out repairs to such damaged services and utilities continuously to completion, including working beyond regular working hours.

9 CUTTING AND PATCHING

- 9.1 Execute Work to avoid damage to other Work.
- 9.2 Execute cutting, fitting and patching including excavation and fill to complete the Work.
- 9.3 Employ appropriate trades with skilled labour to perform cutting Work.
- 9.4 Fit Work segments together, to integrate with penetrations through surfaces and with other Work.
- 9.5 Remove and replace defective and non-conforming Work.
- 9.6 Do any drilling, cutting, fitting, patching and finishing that may be required to make the various classes and kinds of other Work fit together in a professional and finished manner. Make watertight connections with adjoining structures.
- 9.7 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- 9.8 Execute Work by methods to avoid damage to other Work and which will provide proper surfaces to receive patching and finishing.
- 9.9 Cut Products using proper equipment and methods. On rigid materials, use a masonry saw or core drill. Pneumatic or impact tools are not allowed on masonry work without prior approval.
- 9.10 Where new Work connects with existing structures, cut, patch and make good existing work to match original condition.
- 9.11 Ensure compatibility between installed Products and ensure security of installation.
- 9.12 Restore Work with new Products in accordance with requirements of the Contract Documents.
- 9.13 Fit Work airtight to pipes, sleeves, ducts, conduits and other penetrations through surfaces.
- 9.14 Properly prepare surfaces to receive patching and finishing.

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

10 FIRE RATINGS

- 10.1 Where a material, component or assembly is required to be fire rated, the fire rating shall be as determined or listed by one of the following testing authorities acceptable to the authorities having jurisdiction:
- .1 Underwriters' Laboratories of Canada.
 - .2 Underwriters' Laboratories Inc.
 - .3 Factory Mutual Laboratories.
 - .4 The National Research Council of Canada.
 - .5 The National Board of Fire Underwriters.
 - .6 Intertek Testing Services.
- 10.2 Where reference is made to only one testing authority an equivalent fire rating as determined or listed by another of the testing authorities is acceptable if approved by authorities having jurisdiction. Obtain and submit such approval of authorities, in writing when requesting acceptance of a proposed equivalent rating or test design.

11 CODES

- 11.1 Reference is made to standards in the specifications to establish minimum acceptable standards of materials, products and workmanship. Ensure that materials, products and workmanship meet or exceed requirements of the reference standards specified.
- 11.2 In the event of conflict between documents specified herein, execute the Work in accordance with the most stringent requirements.

12 STANDARDS

- 12.1 Where a material or product is specified in conjunction with a referenced standard, do not supply the material or product if it does not meet the requirements of the standard. Supply another specified material or product, or an acceptable material or product of other approved manufacture which does meet the requirements of the standard, at no additional cost to the Owner.
- 12.2 Where no standard is referred to, provide materials, products and workmanship which meet requirements of the applicable standards of the Canadian Standards Association, Canadian General Standards Board, Ontario Provincial Standard Specifications (OPSS), Ontario Provincial Standard Drawings (OPSD) and the applicable building code. References to "Measurement for Payment" and "Basis of Payment" in OPSS standard documents are not applicable to this Contract.
- 12.3 If there is question as to whether a material, product or system is in conformance with applicable standards, the Consultant reserves the right to have such materials, products or systems tested to prove or disprove conformance. The cost for such testing will be paid by the

Owner in the event of conformance with contract Documents or by the Contractor in the event of non-conformance.

- 12.4 Where application, installation and workmanship standards are cited, it is intended that referenced standards form the basis for minimum requirements of the specified item and specifications supplement the standards unless specified otherwise.
- 12.5 Matters may be dealt with in part by these specifications which are also dealt with, under the same or similar headings in cited standard. It is not intended that these specifications take the place of the standards but supplement them, unless specified otherwise.
- 12.6 Where reference is made to manufacturer's directions, instructions or specifications they shall include full information on storing, handling, preparing, mixing, installing, erecting, applying, or other matters concerning the materials pertinent to their use and their relationship to materials with which they are incorporated.

13 PRE-CONSTRUCTION MEETING

- 13.1 Attend a pre-construction meeting with the Owner, arranged and conducted by the Consultant.
- 13.2 Co-ordinate and organize attendance by representatives of major Subcontractors and parties in contract with the Contractor.
- 13.3 Consultant will arrange attendance of other interested parties not responsible to the Contractor.
- 13.4 Consultant will distribute copies of Agenda prior to meeting.
- 13.5 Be prepared to provide specific information relative to agenda items as they are pertinent to the Contract.
- 13.6 Record minutes of meeting and distribute typewritten copies to all participants and other interested parties, within one week of meeting date.

14 PROGRESS MEETINGS

- 14.1 Attend regularly scheduled progress meetings to be held on Site at times and dates that are mutually agreed to by the Owner, Consultant, and Contractor.
- 14.2 Co-ordinate and organize attendance of individual Subcontractors and material suppliers when requested. Relationships and discussions between Subcontractor participants are not the responsibility of the Consultant and do not form part of the meetings content.
- 14.3 Ensure that Contractor representatives in attendance at meetings have required authority to commit Contractor to actions agreed upon. Assign same persons to attend such meetings throughout the contract period.
- 14.4 Inform the Consultant in advance of meetings regarding all items to be added to the agenda.
- 14.5 Consultant will distribute copies of Agenda prior to meeting.

- 14.6 Be prepared to provide specific information relative to agenda items at each meeting as they are pertinent to the Contract.
- 14.7 Agenda will include but not be limited to the following topics as are pertinent to the Contract.
- .1 Review and agreement of previous minutes.
 - .2 Construction Safety.
 - .3 Status of Submittals.
 - .4 Quality Control.
 - .5 Coordination.
 - .6 Contract Schedule.
 - .7 Work plan up to next scheduled meeting.
 - .8 Requests for information/clarification.
 - .9 Contemplated changes.
- 14.8 Record minutes of meeting and distribute typewritten copies to all participants and other interested parties, within one week of meeting date.

15 PRODUCT DATA

- 15.1 Before delivery of Products to the Site, submit Product data as specified in each section or as requested by the Consultant.
- 15.2 Submit manufacturer's Product data for systems, materials, and methods of installation proposed for use. Such literature shall identify systems, each component, and shall certify compliance of each component with applicable standards.
- 15.3 Upon issuance of approved product shop drawings the Contractor shall provide the City with a letter from the flooring manufacturer that the specified product for each area has been ordered. The letter shall verify the product line and estimated quantities for each area.

16 SAMPLES

- 16.1 Before delivery of Products to the Site, submit samples of Products as specified or as requested by the Consultant. Label samples as to origin and intended use in the Work and in accordance with the requirements of the Specification Sections. Samples must represent physical examples to illustrate materials, equipment or work quality and to establish standards by which completed Work is judged.
- 16.2 Ensure samples are of sufficient size and quantity, if not already specified, to illustrate:
- .1 The quality and functional characteristics of Products, with integrally related parts and attachment devices.
 - .2 Full range of colours available.
- 16.3 Notify the Consultant in writing, at time of submission, of any deviations in samples from requirements of the Contract Documents and state the reasons for such deviations.
- 16.4 Identify samples with Project name, Contract number, date, Contractor's name, number and description.

- 16.5 If samples are not acceptable, both samples will be returned. If samples are acceptable, one sample will be so indicated and returned. Be responsible for the cost of samples that are not accepted and for resubmission of samples.
- 16.6 Acceptable samples shall serve as a model against which the products incorporated in the work shall be judged.
- 16.7 Each Product incorporated in the Work shall be precisely the same in all details as the acceptable sample.
- 16.8 Should there be any change from the accepted sample, submit in writing for approval of the revised characteristics and resubmit samples of the Product for approval if requested.
- 16.9 When samples are very large, require assembly, or require evaluation at the Site, they may be delivered to the Site, but only with approval and as directed.

17 SHOP DRAWINGS

- 17.1 Arrange for the preparation of shop drawings as called for in the Contract Documents or as may be reasonably requested by the Consultant. The Contractor and each Subcontractor shall operate as experts in their respective fields and all shop drawings and samples shall conform to the requirements of the Contract Documents.
- 17.2 The term “shop drawings” means drawings, diagrams, schematics, illustrations, schedules, performance charts, brochures and other data which are required to illustrate details of the Work.
- 17.3 In addition to shop drawings specified in the specification sections, submit shop drawings required by jurisdictional authorities in accordance with their requirements.
- 17.4 Shop drawings shall indicate the following minimum criteria and any additional criteria indicated in the individual specification sections requiring shop drawings:
- .1 Clear and obvious notes of any proposed changes from the Contract Documents.
 - .2 Fabrication and erection dimension.
 - .3 Provisions for allowable construction tolerances and deflections provided for live loading.
 - .4 Details to indicate construction arrangements of the parts and their connections, and interconnections with other work.
 - .5 Location and type of anchors and exposed fastenings.
 - .6 Materials, physical dimensions including thickness and finishes.
 - .7 Descriptive names of equipment.
 - .8 Information to verify that superimposed loads will not affect function, appearance, and safety of the work detailed as well as interconnection work.
 - .9 Assumed design loadings and dimensions and material specifications for load-bearing members.
- 17.5 Include in shop drawing submissions detailed information, templates, and installation instructions required for incorporation and connection of the Work.

- 17.6 Before submitting to the Consultant, review all shop drawings to verify that the Products illustrated therein conform to the Contract Documents. By this review, the Contractor agrees that it has determined and verified all field dimensions, field construction criteria, materials, catalogue numbers and similar data and that it has checked and coordinated each shop drawing with the requirements of the Work and of the Contract Documents. The Contractor's review of each shop drawing shall be indicated by stamp, date and signature of a qualified and responsible person possessing the appropriate authorization.
- 17.7 Be responsible for dimensions to be confirmed and correlated at the Site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the Work of all subtrades.
- 17.8 Submit shop drawings for the Consultant's review with reasonable promptness and in orderly sequence to cause no delay in the Work nor in the work of Other Contractors. At the time of submission, notify the Consultant in writing of any deviations in the shop drawings from the requirements of the Contract Documents. The Contractor will be held responsible for changes made from the Contract Documents which are not indicated or otherwise communicated in writing with the submission.
- 17.9 Drawings submitted by the Contractor as required herein are the property of the Owner who may use and duplicate such drawings where required in association with the Work.
- 17.10 Submit shop drawings, as indicated in each section of the Work, signed and sealed by a licensed Professional Engineer registered in the place of the Work.
- 17.11 Shop drawings shall have distinct, uniform letters, numerals and line thicknesses that will ensure the production of clear legible prints and also facilitate reduced reproduction.
- 17.12 Submissions shall be on unfolded mylar film together with 3 prints of each sheet folded into 216 mm x 280 mm size with title block appearing on outside. However, in instances where catalogue items are specified, three clean copies of the manufacturer's catalogue may be submitted.
- 17.13 Shop drawings shall contain the following identification:
- .1 Project name and Contract number.
 - .2 Applicable 6-digit Contract Specification number describing the item.
 - .3 Location (unit, level, room number, etc.).
 - .4 Name of equipment or Product.
 - .5 Name of Subcontractor or supplier.
 - .6 Signature of Contractor certifying that Shop drawing is in conformance with Contract Documents.
 - .7 On submissions after the first, the following additional identification:
 - .1 The revision number.
 - .2 Identification of the item(s) revised.

- 17.14 Dimensions and designations of elements shall be shown in the same system of measurement used on the applicable Contract Drawings.
- 17.15 The Consultant reserves the right to refuse acceptance of drawing submissions not meeting the above requirements.
- 17.16 The Consultant's review will be for conformity to the design concept and for general arrangement only and such a 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 unless a deviation on the shop drawings has been approved in writing by the Consultant. Review does not mean that Consultant approves detail inherent in shop drawings, responsibility which shall remain with Contractor submitting same.
- 17.17 The Contractor shall make any changes in shop drawings which the Consultant may require consistent with the Contract Documents and re-submit unless otherwise directed by the Consultant. When re-submitting the shop drawings, the Contractor shall notify the Consultant in writing of any revisions other than those requested by the Consultant.
- 17.18 Only drawings noted for revision and resubmission need to be resubmitted.
- 17.19 File one copy of each submitted shop drawing at the Site.

18 CERTIFICATES

- 18.1 Submit certificates that are required by authorities having jurisdiction or that are requested in the specification sections.
- 18.2 Clearly show on each certification the name and location of the Work, name and address of Contractor, quantity and date of shipment and delivery and name of certifying company.
- 18.3 Certificates shall verify that Products and/or methods meet the specified requirements and shall include test reports of acceptable testing laboratories to validate certificates.
- 18.4 Submit certificates in duplicate and signed by an authorized representative of the certifying company.

19 EXTENDED WARRANTIES

- 19.1 Submit extended warranties as requested in sections of the Specifications showing title and address of Contract, warranty commencement date and duration of warranty.
- 19.2 Extended warranties shall commence on termination of the standard warranty specified in the conditions of the contract and shall be an extension of these provisions. Clearly indicate what is being warranted and what remedial action is to be taken under the warranty. Ensure warranty bears the signature and seal of the Contractor.
- 19.3 Submit each extended warranty on a form that is acceptable to the Owner and Consultant.

20 INSPECTION AND TEST REPORTS

- 20.1 Submit inspection and test reports as specified in the Sections of the specifications for “Source Quality Control” and “Field Quality Control” within 3 working days of inspection or testing. If immediate action is required by the Contractor or Consultant inform the Consultant immediately and submit inspection and testing report within one working day.
- 20.2 Submit 3 copies of reports submitted with certificates of compliance indicating but not limited to the following:
- .1 Project name and number.
 - .2 Date of inspection or test and date report is issued.
 - .3 Name and address of inspection and testing company.
 - .4 Name and signature of inspector or tester.
 - .5 Identification of Product and Specification Section covering inspected or tested work.
 - .6 Specified requirements for which the inspection or testing was performed and results of inspections or tests.
 - .7 Location of inspection or from which tested material was derived.
 - .8 Overview of inspection and testing methods and procedures.
 - .9 Remarks and observations on compliance with Contract Documents.
- 20.3 Inspection and test reports shall be signed by a responsible officer of the inspection and testing company.

21 SCHEDULES

- 21.1 Be responsible for planning and scheduling of the Work. As a minimum, prepare and update the following schedules:
- .1 Contract Schedule.
 - .2 Detailed Construction Schedule.
- 21.2 Be responsible for ensuring that Subcontractors plan and schedule their respective portions of the Work. Subcontractor's schedules shall form part of the above mentioned schedules.
- 21.3 Contract Schedule:
- .1 Prepare and submit the Contract Schedule within two weeks following award of Contract. This schedule, once it is reviewed by the Consultant and if it meets the Consultant's project requirements, will become contractual.
 - .2 The Contract Schedule shall be developed using a logic network technique for planning and scheduling.
 - .3 The Contract Schedule shall be submitted for approval in its optimum levelled form. This presentation may be in either a time scaled network or a bar chart form. It shall be subdivided into either work areas or systems as applicable.
 - .4 The Contract Schedule shall include the following information:
 - .1 Starting and ending dates of each activity including the float periods;
 - .2 Manpower requirements for each activity;
 - .3 Interdependency with activities of other Contractors;
 - .4 Dates specified in the Contract Documents;
 - .5 Dates on which specific data will be required for submittal, i.e., Vendor data, drawings for review, etc.

- .5 This schedule shall be reviewed and updated monthly by the Contractor so as to reflect any Contract changes as well as major changes to the schedule.

21.4 Detailed Construction Schedule:

- .1 Prepare and submit a detailed construction schedule within two weeks of final review and acceptance of the Contract Schedule. This schedule, once it is reviewed and accepted by the Consultant, will be updated and submitted monthly with the Contract Schedule and weekly once the Contractor starts on Site.
- .2 This schedule shall cover the construction period. It will show, in detail, activities on a daily basis indicating durations, manpower and constraints. The activities shown on this schedule shall further clarify or detail the activities shown on the Contract Schedule.
- .3 The detailed construction schedule shall be presented in a bar chart form.
- .4 Please note the dates where the building is shut down for maintenance are specified in the RFQ. Construction schedule shall be accordance with the schedule set out in the RFQ.

22 INSPECTION AND TESTING

- 22.1 Be responsible for inspection and testing as required by the Contract Documents, statutes, regulations, by-laws, standards or codes or any other jurisdictional authority. Give the Consultant timely notice of the readiness for inspection, date and time for such inspection for attendance by the Consultant.
- 22.2 Verify by certification that specified products meet the requirements of reference standards specified in the applicable specification sections.
- 22.3 Conduct testing, balancing and adjusting of equipment and systems specified in applicable mechanical and electrical specifications sections by independent testing company.
- 22.4 Source And Field Quality Control specified in Other Sections:
 - .1 This Section includes requirements for performance of inspection and testing specified under Source Quality Control and Field Quality Control in other Sections of the specifications.
 - .2 Do not include in work of this Section responsibilities and procedures that relate solely to an inspection and testing company's functions that are specified in another Section which is paid for directly by the Owner. Such information is included in this Section for Contractor's information only.
- 22.5 Do not limit responsibility for ensuring that products and execution of the work meet Contract requirements, and inspection and testing required to this end, to specified inspection and testing.

23 TOLERANCES FOR INSTALLATION OF WORK

- 23.1 Unless specifically indicated otherwise, Work shall be installed plumb, level, square and straight.
- 23.2 Unless acceptable tolerances are otherwise specified in specification sections or are otherwise required for proper functioning of equipment, site services, and mechanical and electrical systems:
 - .1 "Plumb and level" shall mean plumb or level within 1 mm in 1 m.

- .2 "Square" shall mean not more than 10 seconds lesser or greater than 90 degrees.
- .3 "Straight" shall mean within 1 mm under a 1 m long straightedge.
- .4 "Flush" shall mean within:
 - .1 6 mm for exterior concrete, masonry, and paving materials.
 - .2 1 mm for interior concrete, masonry, tile and similar surfaces.
 - .3 0.05 mm for other interior surfaces.

23.3 Allowable tolerances shall not be cumulative.

24 DEFECTS

24.1 Defective products, materials and workmanship found at any time prior to Contract Completion will be rejected regardless of previous inspections, testing, and reviews of the Work. Inspections, testing, and reviews shall not relieve the Contractor from their responsibility, but are a precaution against oversight or error. Remove and replace defective and rejected products, materials, systems, and workmanship. Be responsible for delays and expenses caused by rejection.

25 TEMPORARY CONTROLS

- 25.1 Prevent unauthorized entry to the Site. Barricade, guard or lock access points to the satisfaction of the Consultant and post "NO TRESPASSING" signs.
- 25.2 Install signs for movement of people around Work Site as required and directed by the Consultant.
- 25.3 Provide secure, rigid guide rails and barricades around deep excavations and open edges of floors as required for protection of Work, workers, and the public.
- 25.4 Remove barricades upon Contract Completion unless otherwise noted on the Contract Drawings or as directed by the Consultant.

26 TEMPORARY WORKS

- 26.1 Installation and Removal: Provide temporary utilities, facilities and controls in order to execute the Work expeditiously. Remove from Site all such Work after use.
- 26.2 Temporary Power and Lighting Systems:
 - .1 Supply, install and maintain electrical power and necessary electrical equipment. Connections will be made available to any part of the Work within distance of a 30 m extension.
 - .2 Provide temporary lighting of adequate intensity to illuminate construction activities.
 - .3 Make all necessary arrangements for and pay all costs for a temporary electrical service of sufficient capacity to supply temporary lighting, operation of power tools, and equipment for all construction, implementation, and inspection and testing purposes. Supply and install necessary temporary cables and other electrical equipment and make all temporary connections as required.

- .4 Temporary power distribution wiring shall comply with Ontario Hydro Electrical Safety Code. Obtain inspection certificates for temporary electrical work.
 - .5 Maintain the lighting systems in operation during the life of the Contract. Replace burned or missing lamps immediately.
 - .6 Upon Contract Completion, remove electrical plant and temporary lighting from the Site.
 - .7 Pay all costs for electrical energy consumed prior to Contract Completion.
- 26.3 Water Supply:
- .1 Provide and pay for a continuous supply of potable water for construction use.
 - .2 Provide and maintain all temporary lines, extensions and hoses as required. Remove all temporary connections and lines on completion of the Work and make good any damage.
- 26.4 Temporary Heating:
- .1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.
 - .2 Construction heaters used inside buildings must be vented to the outside or be flame less type. Solid fuel salamanders are not permitted.
 - .3 Maintain temperatures of minimum 10oC in areas where construction is in progress unless otherwise indicated in the Contract Documents. Protect exposed and adjacent services from freezing. Repair at no cost to the Owner any such services, buildings or other utilities disrupted by freezing.
 - .4 Ventilate heated areas and keep structures free from exhaust combustion gases.
 - .5 The permanent heating system of the building or portions thereof may be used when available only upon written permission by Consultant.
- 26.5 Contractor's Drainage System: Provide and maintain a temporary drainage system of sufficient capacity and efficiency to maintain the excavation free of water during the construction period. Do not use any portion of the permanent drainage system without the permission of the Consultant. Remove the temporary system upon Contract Completion.
- 27 PROTECTION**
- 27.1 Protection of Public Area: Protect surrounding private and public property from damage during performance of the Work.
- 27.2 Protection of Building Finishes and Equipment:
- .1 Provide protection for existing structure, finished and partially finished building finishes, waterproofing systems, and equipment during performance of the Work.
 - .2 Cover Owner's equipment and plant within the Site with 6 mil PVC sheet, or equal, taped to make it dust-tight. Equipment and existing work moved or altered to facilitate construction, movement of Products or equipment shall be stored, protected with dust-tight covers and subsequently returned to its original location.
 - .3 Obtain approval from the Consultant prior to the installation of temporary supporting devices into existing roof, ceiling, or wall members for the erecting of equipment or machinery. Repair roof, ceiling, and wall members used for this purpose to the satisfaction of the Consultant.
 - .4 Provide necessary screens, covers and hoarding as required.
 - .5 Any Products or equipment damaged while carrying out the Work shall be restored with new Products or equipment matching the original equipment. Damage shall include harm

resulting from all construction work, such as falling objects, wheel and foot traffic, failure to remove debris, operation of machinery and equipment, and scaffolding and hoisting operations.

27.3 Fire Protection:

- .1 Take precautions to prevent fires. Provide and maintain temporary fire protection equipment of a type appropriate to the hazard anticipated in accordance with authorities having jurisdiction, governing codes, regulations, by-laws and to the satisfaction of the Consultant and insurance authorities.
- .2 Open burning of rubbish is not permitted on the Site.

27.4 Report any discharge of a contaminant to the Authorities Having Jurisdiction.

28 PEST CONTROL

- 28.1 Be responsible to provide control measures, restraining procedures, and treatments to prevent infestation and spread of insects, rodents and other pests deemed to be present at Site and/or noticed during course of the Work. Carry out fumigation, pest control procedure, and posting of warning signs, notices including contents of such notices in accordance with requirements of Pesticides Act and any other authorities having jurisdictions. Pesticides used shall be in accordance with Canada Pest Control Products Act, and provincial and municipal regulations.

29 SITE MAINTENANCE

- 29.1 Maintain the Site and adjacent premises in a clean and orderly condition, free from debris and other objectionable matter. Immediately remove rubbish and surplus Products, equipment and structures from the Site. If the Site is not cleaned (within 48 hours after the Contractor has been instructed to do so), the Consultant may clean the Site and retain the cost from monies due, or to become due, to the Contractor.
- 29.2 When the Work is substantially performed, remove surplus Products, tools, construction machinery and equipment not required for the performance of the remaining Work.

30 SITE STORAGE AND OVER LOADING

- 30.1 Confine the Work and operations of employees to limits indicated by the Contract Documents. Do not unreasonably encumber the Site with Products.
- 30.2 Products shall be stored only in areas designated or approved by the Consultant, and shall not be left lying on streets, sidewalks, boulevards or elsewhere within public view. Products which the Consultant may permit to be stored elsewhere than in the Contractor's storage areas shall be neatly stacked or otherwise disposed and shall be so maintained.
- 30.3 Do not load or permit to be loaded any part of the Work with a weight or force that it is calculated to bear safely. Be solely responsible and liable for damages resulting from violation of this requirement. Provide temporary supports as strong as permanent support.
- 30.4 Do not cut, drill or sleeve load bearing members unless shown on drawings or otherwise approved by the Consultant in writing for each location.

- 30.5 Site storage and loading requirements to be in accordance with the Ontario Occupational Health and Safety Act and Regulations for Construction Projects.

31 SUBSTITUTIONS

- 31.1 Requests for substitutions must be submitted as a question during the tender period for Consultant review. Upon review, an addendum will be issued confirming if substitutes will be accepted prior to Notification of Award. Substitutions will be considered by the Consultant provided that:
- .1 The proposed substitutions have been investigated and complete data are submitted in accordance with the Specifications.
 - .2 Data relating to changes in the Contract Schedule, if any, and relation to other Work have been submitted.
 - .3 Same warranty is given for the substitution as for the original Product specified.
 - .4 All claims are waived for additional costs related to the substitution which may subsequently arise.
 - .5 Installation of the accepted substitution is coordinated into the Work and that full responsibility is assumed when substitutions affect other work. Make any necessary changes required to complete the Work. Revisions to the drawings for incorporation of the substitutions shall be made by the Consultant and all costs associated with the revisions shall be borne by the Contractor.
- 31.2 Substitutions to methods or process described in the Specifications or drawings, may be proposed for the consideration of the Consultant. Ensure that such substitutions are in accordance with the following requirements:
- .1 Time spent by the Consultant in evaluating the substitution shall not be the basis for a claim by the Contractor for extensions to the Contract Time.
 - .2 Clearly indicate how the proposed substitutions would be advantageous to the Owner or in the opinion of the Contractor would improve the operation of the installation.
 - .3 Be responsible for substitutions to methods or processes concerning such Work and ensure that the warranty covering all parts of the Work will not be affected.
 - .4 The cost of all changes in the work of Other Contractors, necessitated by the substituted methods or processes, if accepted, is borne by the Contractor.
 - .5 The substituted methods or processes fit into space allotted for the specified methods or processes. Revisions to the drawings for incorporation of the substitutions shall be made by the Consultant and all costs associated with the revisions shall be borne by the Contractor.
- 31.3 Substitutions will not be considered if:
- .1 They are indicated or implied on shop drawings or Product data without formal request.
 - .2 Acceptance will require substantial revision of the Specifications and Drawings.
- 31.4 Do not substitute Products or methods or processes into the Work unless such substitutions have been specifically approved for the Work by the Consultant.
- 31.5 Approved substituted Products shall be subject to the Consultant's inspection and testing procedures. Approved substituted Products shall only be installed after receipt of the Consultant's written approval.

- 31.6 The Contract Price will be adjusted accordingly to any and all credits arising from the substitutions mentioned above.

32 APPROVAL OF PRODUCTS AND INSTALLATION METHODS

- 32.1 Wherever in the Specifications it is specified that Products and installation methods shall meet approval of Authorities having Jurisdiction, underwriters, the Consultant, or others, such approval shall be in writing.

33 AVAILABILITY

- 33.1 If delays in supply of Products are foreseeable, notify the Consultant of such, in order that remedial action may be authorized in ample time to prevent delay in performance of Work.
- 33.2 In the event of failure to notify the Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, the Consultant reserves the right to direct the Contractor to take the following measures at no increase in Contract Price:
- .1 Substitute more readily available Products of similar or better quality and character, or
 - .2 Temporarily install another Product until such time as the specified Product becomes available, at which time the temporarily installed product shall be removed and the specified Product installed.

34 DELIVERY, STORAGE, HANDLING AND PROTECTION

- 34.1 Be responsible for handling and delivery of Products. Protect Products from damage during handling, storage and installation. Deliver store and handle items in accordance with manufacturer's instructions and as specified. Be responsible for all costs of delivery, loading and off-loading, and for transportation back to its origin for correction, if required, due to damage or defect. Reject materials and Products delivered to the Site which are damaged.
- 34.2 Manufacture, pack, ship, deliver, and handle Products so that no damage occurs to structural qualities and finish appearance, nor in any other way which is detrimental to their function and appearance.
- 34.3 Ensure that Products, while transported, are not exposed to an environment which would increase their moisture content beyond the maximum specified.
- 34.4 Organize delivery of materials, Products and equipment to, and removal of debris and equipment from, the site and surrounding property.
- 34.5 Schedule early delivery of Products to enable Work to be executed without delay. Before delivery, arrange for receiving at the Place of the Work.
- 34.6 Shop assemble work for delivery to Site in size easily handled and to ensure passage through building openings.
- 34.7 Deliver packaged Products, in original unopened wrapping or containers, with manufacturer's seals and labels intact.
- 34.8 Label packaged products to describe contents, quantity, and other information as specified.

- 34.9 Labels attesting that materials conform to specified reference standards will be acceptable as verification that contents meet specified requirements. In the absence of labels, submit affidavits to validate conformance of Product to reference standards, as requested by the Consultant.
- 34.10 Label fire-rated Products to indicate Underwriters' Laboratories approval.
- 34.11 Handle and store materials and products in such a manner that no damage is caused to the materials and products, the Work, the Site and surrounding property.
- 34.12 Locate products on Site in a manner to cause minimal interference with the Work and building activities.
- 34.13 Store Products off the ground, in a manner to prevent damage, adulteration, deterioration and soiling to the Products, other building components, assemblies, other products, the structure, the Site and surrounding property, and in accordance with manufacturer's instructions when applicable.
- 34.14 Store packaged or bundled Products in original and undamaged condition complete with written application instructions. Keep manufacturer's seals and labels intact. Do not remove from packaging or bundling until required in the Work.
- 34.15 Do not place or store materials and Products in corridors, public areas, streets, lanes, passageways or similar locations.
- 34.16 Store Products so as not to create any overloading conditions to any part of the building, structure, falsework, form work and scaffolding.
- 34.17 Store Products subject to damage from weather in weatherproof enclosures.
- 34.18 Store cementitious Products clear of earth or concrete floors, and away from walls.
- 34.19 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.
- 34.20 Store sheet materials and lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.
- 34.21 Store and handle flammable liquids and other hazardous materials in approved safety containers and as otherwise prescribed by safety authorities. Store no flammable liquids or other hazardous material in bulk within the Work.
- 34.22 Store and mix paints in a heated and ventilated room or area assigned for this purpose. Keep this room or area locked when unattended. Remove oily rags and other combustible debris from the Place of the Work daily. Take every precaution necessary to prevent spontaneous combustion.

- 34.23 Protect prefinished metal surfaces by protective coatings or wrappings until time of final cleanup. Protection shall be easily removable without damage to finishes. Do not permit strippable tape or coatings to become baked on surfaces which they protect.
- 34.24 Touch-up damaged factory finished surfaces to Consultant's satisfaction. Use primer and paint to match original.
- 34.25 Protect glass and other finishes against heat, slag and weld splatter by provision of adequate shielding. Do not apply Visible markings to surfaces exposed to view in finished state or that receive transparent finishes.
- 34.26 Protect surfaces of completed work exposed to view from staining, disfigurement and all other damage by restriction of access or by use of physical means suitable for the material and surface location.
- 34.27 Adequately protect trowelled concrete floors from damage. Take special measures when moving heavy loads or equipment on them.
- 34.28 Keep concrete floors and finished free from oils, grease or other material likely to damage or discolour them or affect bond of applied finishes. Once building is enclosed, keep floors as dry as possible after curing.
- 34.29 Protect finished flooring from pedestrian traffic with minimum reinforced kraft paper temporary protection, secured in place and with joints sealed by reinforced pressure sensitive tape. Maintain protection in place until contract completion.
- 34.30 Protect finished flooring from continuing construction work and delivery of products with plywood panels of minimum 6 mm thickness with joints between panels sealed with reinforced pressure sensitive tape. Maintain protection in place until work and deliveries are complete.
- 34.31 Make good or replace damaged materials to the satisfaction of the Consultant.
- 34.32 Hazardous Materials Information:
 - .1 Comply with 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 (MSDS) in accordance with jurisdictional authorities.
 - .2 Deliver copies of Material Safety Data Sheets (MSDS) to the Consultant on all Products intended for use in the Work and designated as a "controlled product."

35 MANUFACTURER'S INSTRUCTIONS

- 35.1 Unless otherwise indicated in the Specifications, fabricate, install, apply, connect, install, erect, use, clean, and condition Products in accordance with manufacturer's instructions except where more stringent requirements are specified. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.

- 35.2 Notify the Consultant in writing of conflicts between the Specifications and manufacturer's instructions, so that the Consultant may establish the course of action. If requested, make a copy of those instructions available at the Site.
- 35.3 In cases of improper installation or erection of Products, due to failure in complying with these requirements, the Consultant may direct removal and re-installation at no increase in Contract Price.

36 WORKMANSHIP

- 36.1 Workmanship shall be the best quality, 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.
- 36.2 Do not employ any unfit person or anyone unskilled in their required duties. The Consultant reserves the right to require the dismissal from the Place of the Work, workers deemed incompetent, careless, insubordinate or otherwise objectionable.
- 36.3 Decisions as to the quality or fitness of workmanship in cases of dispute rest solely with the Consultant, whose decision is final.
- 36.4 Give particular attention to finished dimensions and elevations of the Work. Make finished Work fit indicated spaces accurately. Make finished Work flush, plumb, true to lines and levels and accurate in all respects.
- 36.5 In finished areas, conceal pipes, ducts, conduit and wiring in floors, walls, ceilings, chases, or behind furring except where indicated otherwise.
- 36.6 Ensure that service poles, fill-pipes, vents, regulators, metres and similar service installations are located in inconspicuous locations. If not indicated on drawings, verify location of service installations with Consultant prior to commencing installation.
- 36.7 Ensure that integrity of fire separations is maintained where they are penetrated.
- 36.8 Finish access panels and doors to match adjacent wall and/or ceiling finish unless otherwise specified or indicated.
- 36.9 Keep surfaces, on which finished materials will be applied, free from grease, oil, and other contamination which would be detrimental in any way to the application of finish materials.
- 36.10 Enforce fire prevention methods at site. Do not permit fires, open flame heating devices or accumulation or debris. Use flammable materials only if all safety precautions are taken. Provide and maintain in working order ULC labelled fire extinguishers of types suitable for fire hazard in each case and locate them in prominent location and to approval of jurisdictional authorities.
- 36.11 Where flammable materials are being applied, ensure that adequate ventilation is provided, spark-proof equipment is used, and smoking and open flames are prohibited.

37 DIMENSIONS

- 37.1 Check all dimensions at the Site before fabrication and installation commences and report discrepancies to the Consultant.
- 37.2 Where dimensions are not available before fabrication commences, ensure that dimensions required are agreed upon between the parties concerned.
- 37.3 Prior to commencing work, ensure that clearances required by jurisdictional authorities can be maintained.
- 37.4 Wall thickness and openings shown on the drawings may be nominal only; ascertain actual sizes at the Site.
- 37.5 Verify dimensions of shop fabricated portions of the Work at the Site before shop drawings and fabrications are commenced. The Owner will not accept claims for extra expense because of non-compliance with this requirement.
- 37.6 Fabricate and erect manufactured items, shop fabricated items, and items fabricated on or off site, to suit site dimensions and site conditions.
- 37.7 In areas where equipment is to be installed, check dimensional data on equipment to ensure that area and equipment dimensions are compatible with necessary access and clearance provided. Ensure that equipment supplied is dimensionally suitable for space provided.
- 37.8 Leave areas clear where space is indicated to be reserved for future equipment, including access to such future equipment.
- 37.9 Whether shown on the Drawings or not, leave adequate space and provision for servicing of equipment and removal and reinstallation of replaceable items such as motors, coils and tubes.

38 EXPANSION, CONTRACTION, AND DEFLECTION

- 38.1 Conform to manufacturer's recommended installation temperatures. If items, components, assemblies, systems, and finishes are installed at temperatures different from operation or service temperatures, make provisions for expansion and contraction in service as acceptable to manufacturer and consultant. Repair all resulting damage should expansion provisions provide inadequate.
- 38.2 Make provisions for expansion and contraction due to temperature changes within components, Products and assemblies, and between adjacent components, Products and assemblies, and due to building movements including but not limited to creep, column shortening, deflection, sway and twist. Ensure provisions for expansion, contraction and building movements prevent damages from occurring to and within components, Products and assemblies.
- 38.3 Make adequate allowance at wall and partition heads for deflection of the structure above. Determine requirements from Consultant where additional information is required. Where partitions butt to underside of floor assembly, or structural framing, the clearance shall be based on the span of the members supporting the floor or structural framing. In making such

allowance use methods which maintain the integrity of the wall or partition as a sound, and/or fire barrier.

- 38.4 Make provisions in pipes, plenums, ducts and vessels containing air and fluids as is necessary to prevent damage due to fluid and air induced pressure, surges and vibrations, to pipes, plenums, ducts and vessels and to adjacent components, assemblies and construction to which pipes, ducts, plenums and vessels are attached or pass through.

39 DIELECTRIC SEPARATION

- 39.1 Ensure that a dielectric separator is provided in a permanent manner over entire contact surfaces to prevent electrolytic action (galvanic corrosion) between dissimilar materials. Similarly, prevent corrosion to aluminum in contact with alkaline materials such as contained in cementitious materials.

40 PRODUCTS AT SOUND ATTENUATING PARTITIONS

- 40.1 Avoid sound transfer at sound attenuating partitions by careful location and treatment of mechanical and electrical equipment, ducts, grilles, diffusers, electrical outlets and boxes, and similar items. Where electrical boxes are back-to-back, serving each side, locate them at least 250 mm apart laterally and, if interconnected, use flexible connections.

41 FASTENINGS

- 41.1 Include in the work of each section necessary fastenings, anchors, inserts, attachment accessories, and adhesives. Where installation of devices is in work of other sections, deliver and locate devices in ample time for installation.
- 41.2 Do not install fibre, plastic or wood plugs or blocking for fastenings in masonry, concrete, or metal construction, unless specified or indicated on drawings.
- 41.3 Install work with fastenings or adhesives in sufficient quantity to ensure permanent secure anchorage of materials, construction, components and equipment under static conditions, and to resist building thermal movement, creep and vibration.
- 41.4 Provide metal fastenings and accessories in same material, texture, colour, sheen and finish as metal on which they occur, unless indicated otherwise.
- 41.5 Prevent electrolytic action between dissimilar metals and materials.
- 41.6 Space anchors within their load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- 41.7 Conceal fasteners where indicated. Keep exposed fastenings to a minimum, space evenly and in an organized symmetrical pattern.
- 41.8 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

42 ADJUSTING

- 42.1 Ensure that all components of assemblies fit snugly, accurately and in true planes, and that moving parts operate positively and freely, without binding and scraping.
- 42.2 Verify that work functions properly and adjust it accordingly to ensure satisfactory operation. Lubricate Products as recommended by manufacturer.

43 DEMONSTRATION AND INSPECTION OF PRODUCTS AND SYSTEMS

- 43.1 Arrange for a demonstration of systems and operating Products upon the 100% completion of their installation and prior to certification for Substantial Performance.
- 43.2 Include in the arrangements for the attendance of the Consultant, Owner, jurisdictional authorities, and personnel assigned by the Owner for the operation of the systems and/or products.
- 43.3 Demonstrations shall be conducted by the Subcontractor responsible for the installation of the systems and/or Product, assisted by representatives of the manufacturer or supplier. All personnel conducting the demonstration shall be completely knowledgeable of all conditions of the operating, functioning and maintenance of the systems and/or Products.
- 43.4 Owner's representative will acknowledge the successful completion of each demonstration on a form provided by the Contractor. The form shall be agreed to by the Owner, Consultant and Contractor prior to demonstration and testing.
- 43.5 Submit copies of letters from manufacturers of Systems and/or Products before making application for certificate of Substantial Performance to verify that the Products has been installed and connected correctly, and that it is operating in a satisfactory manner. The certification shall be based upon inspection and testing of the Products by competent technical personnel. Include in letter of certification the names of personnel conducting the testing and inspection, the methods of inspection utilized, and the location in the building of the Products certified.
- 43.6 Following submission of letters of certification and their acceptance by the Owner, the owner shall have the right to use the Products on a trial basis and for instructing their personnel in its use.

44 FINAL INSPECTIONS AND CLOSE OUT

- 44.1 Submit proposed closeout procedures and schedule of inspection to Consultant for approval before final demonstrations and inspections commence.
- 44.2 Arrange for, conduct and document final demonstrations, inspections, close-out and take-over at completion of the Work in accordance with procedures described in OAA/OGCA TAKE-OVER PROCEDURES, OAA/OGCA Document No. 100. Where "Architect" is referred to in Document No. 100 it shall mean Consultant.

45 GARBAGE DISPOSAL AND CLEANUP

- 45.1 Subtrades shall provide waste containers for the disposal of all waste materials resulting from performance of their work.
- 45.2 No hazardous or contaminated waste material shall be placed in Owner's waste containers and Subtrades shall make their own arrangements for the disposal off site of any such material resulting from performance of their work.
- 45.3 Subtrades shall remove all regular waste material and debris from their work areas and deposit in the waste containers at the end of each working day. Any clean-up work not performed as requested will be carried out by the Owner with all resultant costs being charged to the Subtrade.

46 CLEANING

- 46.1 Progress cleaning:
 - .1 Remove from finish work, spatters, droppings, soil, labels, and debris, before they set up.
 - .2 Ensure that only cleaning materials are used which are recommended for the purpose by both the manufacturer of the surface to be cleaned and of the cleaning material.
 - .3 Maintain building work areas "broom clean" at least daily, but cleaning shall also be done immediately before finishing work.
 - .4 No waste material may be burned or buried at site. Remove waste as often as required to avoid accumulation, no less than, at the end of each working day.
 - .5 Remove packaging materials and debris from the site immediately after product and equipment is unwrapped or uncrated.
 - .6 Ensure that volatile fluid wastes are not disposed of in storm or sanitary sewers, in open drain courses, or anywhere on site.
 - .7 Do not allow waste material and debris to accumulate in an unsightly or hazardous manner. Sprinkle dusty accumulations with water. Provide containers in which to collect waste material and debris. Dispose of hazardous products in accordance with requirements of jurisdictional authorities.
 - .8 Ensure that cleaning operations are scheduled to avoid deposits of dust or other foreign matter on surfaces during finishing work and until wet or tacky surfaces are cured.
 - .9 Provide instructions for final cleaning of finishing work, and for inclusion in Maintenance and Operating Manuals.
- 46.2 Final cleaning:
 - .1 Before final inspection, replace glass and mirrors broken, damaged, and etched during construction, or which are otherwise defective.
 - .2 In addition to requirements for progress cleaning, Work shall include final cleaning by skilled cleaning specialists on completion of construction.
 - .3 Remove temporary protections and make good defects before commencement of final cleaning.
 - .4 Final cleaning shall remove dust, stains, paint spots, soil, grease, fingerprints, and accumulations of construction materials, interior and exterior to the building for all new work throughout new and existing Building. Work shall be done in accordance with manufacturer's instructions for each material. This work shall include:
 - .1 Washing of interior stone, brick, and concrete floors.
 - .2 Cleaning and polishing of glass, mirrors, porcelain, enamel and finish metals.

- .3 Vacuum cleaning of ceilings, walls and floors.
- .4 Cleaning of resilient flooring.
- .5 Washing clean of glazed wall surfaces.
- .6 Cleaning of hardware, mechanical fixtures, plumbing fixtures, lighting fixtures, cover plates, and equipment, including polishing of their finish metal, porcelain, vitreous, and glass components.
- .5 Maintain cleaning until Owner has taken possession of building or portions thereof.

47 PROGRESS RECORDS

- 47.1 Maintain on site, permanent written records of daily progress of the Work. Records shall be open to review by Consultant and Owner at all times and a copy shall be furnished to Consultant on a weekly basis.
- 47.2 Records shall show dates of commencement, progress and completion of various trades and items of work. Particulars pertaining to number of employees of various trades and type and quantity of equipment employed daily, temperature, protection methods and other such data shall be noted.

48 RECORD (AS-BUILT) DRAWINGS

- 48.1 Authorized deviations from drawings shall be marked in red accurately on digital drawings in a neat, legible manner and shall be dated. Prior to final inspection, transfer the recorded information to a second set of digital drawings of the most recent revision to the drawings and submit both sets to the Consultant.
- 48.2 Maintain record drawings up to date as Work progresses. Status of maintained record drawings may be considered as a condition for validation of applications for payment.
- 48.3 Identify each record drawing as "Contract Record Copy". Always make record drawings available to the Consultant.
- 48.4 Record drawings shall include accurate dimensioned record of deviations and changes in Work from drawings.
- 48.5 Record drawings shall be signed and dated by Contractor.
- 48.6 Submit record drawing to Consultant for review and make corrections as directed by Consultant.
- 48.7 Record drawings shall be completed in AutoCAD format, signed and dated by Contractor.
- 48.8 Record accurately all deviations in the Work.
- 48.9 Accurately record locations of concealed structure, mechanical and electrical services and similar Work not clearly in view, the location of which is required for maintenance, alteration Work and future additions. Do not conceal such Work until the location has been recorded.

- 48.10 Accurately record locations of equipment bases, anchors, concrete pads and roof curbs, sleeves, piping, conduits, ducts, maintenance holes and valves, etc. located either below, outside or within structure.
- 48.11 Where piping, conduits and ducts are underground, underfloor, embedded in concrete or otherwise in inaccessible locations, accurately record with respect to structure column lines or walls and elevations with respect to finished floor levels or grades referenced to the centre line of components.
- 48.12 Accurately record any components which will be in inaccessible locations for Consultant's review before the component is covered, or buried, or made inaccessible.

49 OPERATION AND MAINTENANCE MANUALS

- 49.1 Hand over to the Consultant three (3) copies and one (1) electronic copy of a comprehensive operations and maintenance manual and material suitable [for a training course] for the Owner's maintenance employees. Manuals to cover all Products supplied and installed under the Contract.
- 49.2 Submit draft of the operation and maintenance manuals for the Consultant's review at least 15 days before testing systems and equipment. Incorporate alterations and additions, as found to be necessary during testing, and prepare the final version of the manual from the corrected draft.
- 49.3 Submit final version of operation and maintenance manuals prior to Contract Completion.
- 49.4 Testing of systems and equipment will not be deemed to be complete until the requisite number of copies of the final version of the manuals has been handed over to the Consultant.
- 49.5 If standard literature is incorporated into the operations and maintenance manual, any irrelevant information shall be deleted or suitably noted.
- 49.6 The manuals shall have sufficient detail in order that the Owner can totally maintain the equipment without outside help.
- 49.7 Submit all material in English.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

- .1 This section applies to the daylighting, decommissioning and removal of:
 - .1 underground septic tank and
 - .2 septic leaching bed tile system.
- .2 Contractor shall identify components of existing system and arrange for decommissioning and removals.

1.2 SUMMARY

- .1 Comply with requirements of this Section when performing following Work:
- .2 Refer to laws, by laws, ordinances, rules, regulations and orders of authority having jurisdiction, and other legally enforceable requirements applicable to Work at that area; or become in force during Work performance.
- .3 Obtain necessary permissions and permits from [Municipal Authorities] where closure or obstruction of streets, sidewalks or driveways is required by the work of this Section.

PART 2 Products

2.1 MATERIALS

- .1 Provide necessary materials, equipment, and tarps to prevent spillage or damage of site, and for safe handling and containment of tank and contaminated soils.
- .2 Provide all necessary personal protective equipment, pumps and other equipment as may be necessary.

PART 3 Execution

3.1 Preparation

- .1 Do construction occupational health and safety in accordance with applicable Sections.

3.2 Tank Removal

- .1 Retain an approved septic hauler having license in the jurisdiction for operations and haulage of sewage material
- .2 Pump liquid from tank for disposal prior to removing tank from ground. Retain liquid and dispose as per directions from laboratory or hazardous waste testing facility.

- .3 Disconnect inlet and outlet pipes and remove.
- .4 Disconnect, make safe and remove any electrical connections
- .5 Obtain disposal facility receipts noting proper liquid disposal.

3.3 Storage Tank Disposal:

- .1 Remove dismantled tank to a disposal facility acceptable to authorities having jurisdiction.
- .2 Obtain disposal facility receipts noting proper tank disposal.

3.4 Leaching Bed Removal:

- .1 Disconnect and plug both ends of any underground sewer piping leading to the leaching bed, such as the discharge pipe from the septic tank to the header pipe or distribution box. Use non-shrink cement grout or another sealant, or cap the pipe with a suitable pipe cap.
- .2 Remove the distribution box if present. Follow the same procedure as for tank removal above. Disconnect and cap any inspection ports, remove the ports, and backfill. Cut off and plug any piping before backfilling.
- .3 Once all connections have been disconnected, the remainder of the bed may be abandoned in place.
- .4 Remove all stone and piping from the leaching bed area.
- .5 If any part of the leaching bed has failed at the surface or there is biomaterial contamination, remove the contaminated material and replace it with at least 300mm of clean soil.
- .6 Dispose of material in accordance with the regulations of the authorities having jurisdiction.

3.5 Grading

- .1 Carry out final grading procedures in accordance with civil drawings. Coordinate with installation of site services.

END OF SECTION

Part-1 GENERAL

1.1 SECTION INCLUDES

- .1 Labour, Products, equipment and services necessary for demolition and removals Work in accordance with the Contract Documents.
- .2 Work included: Requirements for demolishing, salvaging and removing wholly or in part the various items designated on the drawings or required to be removed or partially removed for receipt of Work of this Contract, including but not necessarily limited to:
 - .1 Alteration and renovations to existing building.
- .3 Patching, making good openings and chases in walls, floors, including the supply and installation of lintels, channels and finishes.
- .4 Removal of rubbish, debris, demolished fixtures, fitments and items not scheduled to remain the Owner's property, resulting from the demolition and preparatory work.
- .5 Dust control during the operations of the work of this Section.
- .6 Removal shall mean removal from site and safe disposal in a legal manner.

1.2 REFERENCES

- .1 CSA S350-M, Code of Practice for Safety in Demolition of Structures.
- .2 OPSS, Ontario Provincial Standard Specification.

1.3 SUBMITTALS

- .1 Where required by Authorities having jurisdiction, submit a Fire Plan to local fire department for review and approval.
- .2 Submit shop drawings, diagrams and details in accordance with Section 01 00 00.
- .3 30 calendar days prior to start of demolition and removals work, submit for review, drawings, diagrams or details showing sequence of disassembly work and shoring of supporting structures in accordance with authorities having jurisdiction.
- .4 Submit for approval, a plan showing impacts, interruptions and delays to Owner's operations.
- .5 Have submissions signed and sealed by Professional Engineer licensed in Province of Ontario.
- .6 Submit to Consultant, details of where rubble, debris and other materials are to be disposed or reused. Include each disposal/reuse site location, operator's name and business address, type of license under which site operates, and criteria used by site to assess suitability of rubble, debris and other materials for disposal.

- .7 Give notice to Utility Authorities controlling services and appurtenances which will be affected by demolition work.

1.4 QUALITY ASSURANCE

- .1 Prepare waste audits, waste reduction workplans, source separation programs and recycling programs as required by jurisdictional authorities and update programs and implement such programs as required.
- .2 Perform the work of this section in accordance with the 'Environmental Protection Act' including Ontario Regulation 102 and the 'Environmental Assessment Act' including Ontario Regulation 103.
- .3 Conform to Fire Code, Regulation under the Fire Marshals Act.
- .4 The demolition contractor must engage a registered professional engineer who holds a certificate of authorization and an appropriate level of liability insurance to prepare demolition procedures.
- .5 As part of the contract requirements, the engineer for the demolition contractor should be required to sign the general review commitment required by city building departments.

1.5 SITE CONDITIONS

- .1 Interruptions to Owners operations will not be permitted.
- .2 Perform operations, machine and equipment movements, deliveries and removals at times that will permit uninterrupted operations in and around structures, including parking, deliveries, and Site access and egress.

Part-2 PRODUCTS

2.1 MATERIALS

- .1 All materials requiring removal shall become the Contractor's property and shall be removed and disposed of from the site, as the work progresses, unless indicated otherwise.
- .2 Salvaged material:
 - .1 Salvage and stockpile Products, materials, and equipment as specified by Owner, indicated on Site or indicated on drawings.
 - .2 Salvage existing split-faced CMU blocks for re-use as indicated.
 - .3 Coordinate items to be salvaged with Owner.
 - .4 Salvaged materials shall not be chipped, cracked, split, stained or damaged.
 - .5 Store items off moist surfaces.

Part-3 EXECUTION

2.1 GENERAL

- .1 Time is of the essence for this project. Mechanical removal of existing flooring with the use of a Terminator Ride on Floor Scraper or similar machine will only be accepted, no hand held manual equipment will be considered acceptable.
- .2 Clean up rubble and debris, resulting from work promptly and dispose at end of day or place in waste disposal bins. Empty bins on regular basis.
- .3 Stockpiling of rubble, debris, and surplus Products on Site will not be permitted.
- .4 Remove, handle and transport Products indicated by Owner to be salvaged and stored for future use. Transport Products to storage area(s) designated by Consultant. Perform work to prevent any damage to Products during removal and in storage. Products damaged during removal, will be inspected by Consultant. Consultant will determine extent of damage and accept or refuse Products.
- .5 Tag and log all items to be salvaged to the satisfaction of the Consultant. Ensure identification tags do not damage items to be salvaged and are non-permanent, removable and durable.
- .6 Take precautions to guard against movement, settlement or collapse of adjacent services, sidewalks, driveways, or trees. Be liable for such movement, settlement or collapse caused by failure to take necessary precautions. Repair promptly such damage when ordered.

2.2 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.

2.3 PRESERVATION OF REFERENCES

- .1 Record location and designation of survey markers and monuments located within demolition area, prior to removal. Store and restore markers and monuments upon completion of Work or relocate as directed by Consultant.

2.4 PROTECTION

- .1 Prevent movement or damage of adjacent services, paving, and parts of existing structure to remain. Supply and install bracing, and shoring as required. Make good damage caused by demolition to acceptance of Consultant.
- .2 Take precautions to support affected structures. If safety of structure being demolished or services are endangered, cease demolition operations and take necessary action to support endangered item. Immediately inform Consultant. Do not resume demolition until

reasons for endangering have been determined and corrected and action taken to prevent further endangering.

- .3 If movement or settlement occurs, install additional bracing and shoring as necessary and make good damage to acceptance of Consultant.
- .4 Hang tarpaulins where debris and other materials are lowered. Build in around openings with wood and plywood at locations used for removal of debris and materials.
- .5 Prevent debris from blocking surface drainage system, mechanical, and electrical systems which are required to remain in operation.
- .6 Pay particular attention to prevention of fire and elimination of fire hazards which would endanger Work or adjacent structures and premises.
- .7 Supply and install adequate protection for materials to be re-used, set on ground and prevent moisture pick-up. Cover stockpiles of materials with tarpaulins.
- .8 Close off access to areas where demolition is proceeding by barricades and post warning signs.
- .9 Supply, install and maintain legal and necessary barricades, guards, railings, lights, warning signs, security personnel and other safety measures, and fully protect persons and property.
- .10 Dust partitions:
 - .1 Prior to demolition work proceeding in existing structures, temporarily enclose Work areas, access and supply and install dustproof partitions. Design partitions to prevent dust and dirt infiltration into adjoining areas, prevent ingress of water, and to resist loads due to wind.
 - .2 Prevent dust, dirt and water from demolition operations entering operational areas.
 - .3 Adjust and relocate partitions as required for various operations of work.
 - .4 Upon completion of work, remove and dispose of partitions from Site.
- .11 Blasting is not permitted.

2.5 PREPARATION

- .1 Do not disrupt active or energized utilities designated to remain undisturbed.
- .2 Perform rodent and vermin control to comply with health regulations.

2.6 DEMOLITION

- .1 Perform demolition with extreme care. Confine effects of demolition to those parts which are to be demolished.
- .2 Perform work and prevent inconvenience to persons outside those parts which are to be demolished.
- .3 Carry out demolition in accordance with the requirements of CSA S350-M.
- .4 Do not overload floor or wall with accumulations of material or debris or by other loads.
- .5 Perform work to minimize dusting. Keep work area wetted down with fog sprays to prevent dust and dirt rising. Supply and install temporary water lines and connections that may be required. Upon completion, remove installed temporary water lines. Use covered chutes, water down.
- .6 Do not sell or burn materials on Site.
- .7 Remove existing equipment, services, and obstacles where required for refinishing or making good of existing surfaces and replace as Work progresses.
- .8 At end of day's work, leave Work in safe condition with no part in danger of toppling or falling.
- .9 Drainage and sewer system protection:
 - .1 Ensure that no dust, debris or slurry enters drainage and sewer system on Site.
 - .2 Remove and dispose of debris and slurry promptly from Site.
 - .3 Comply with City of Richmond Hill Sewer Use By-Law.
- .10 Remove interior finishes, such as floor finishes, where new finishes are indicated on Drawings.
 - .1 Removal of adhesive applied finishes shall include complete removal to substrate including adhesive. Take adequate care to prevent damage to substrate.
- .11 Remove existing floor finishes, include mortar bed, underlayment or other cleavage membranes, underpad, base, floor moulding and transition strips.
- .12 Where resilient (rubber) floor finishes are scheduled to be removed, include stripping of all adhesive, underlayment or other cleavage membranes and leave sub-base, flush, smooth and level suitable for new floor finish.
- .13 Remove spectator side dasherboard cladding HDPE angles where rubber flooring is indicated to be replaced and reinstall after new flooring is installed.

2.7 DISPOSAL OF MATERIALS

- .1 Remove from Site, rubble, debris, and other materials resulting from demolition and removals work in accordance with Authorities having Jurisdiction, except where specified or indicated on Contract Drawings to be reused.

- .2 Conform to requirements of municipality's Works Department regarding disposal of waste materials.
- .3 Materials prohibited from municipality waste management facilities shall be removed from Site and dispose of at recycling companies specializing in recyclable materials.

2.8 RESTORATION

- .1 Where demolition removed a structure or installation, rough grade and restore area in accordance with Authorities having Jurisdiction.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Comply with requirements of this Section when performing following Work:
- .2 Removal of asbestos-containing materials.
- .3 Comply with requirements of this Section when performing the following work in compliance with Ontario Regulation 278/05 - Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations:
 - .1 Operations involving the removal and/or disturbance of materials that are not classified as Type 1 or Type 2 operations.
 - .2 Removal or disturbance as specified of more than 1 square meter of friable asbestos-containing material during the repair, alteration, maintenance or demolition of a building or any machinery or equipment.
 - .3 Breaking, cutting, drilling, abrading, grinding, sanding or vibrating non-friable asbestos-containing material, if the work is done by means of power tools that are not attached to dust-collecting devices equipped with HEPA filters.
 - .4 Repairing, altering or demolishing all or part of any building in which asbestos is or was used in the manufacture of products.
 - .5 The spray application of a sealant to friable asbestos-containing material.
 - .6 Cleaning or removing air handling equipment, including rigid ducting but not including filters, in a building that has asbestos-containing sprayed fireproofing.
 - .7 Repairing, altering or demolishing all or part of a kiln, metallurgical furnace or similar structure that is made in part of refractory materials that are asbestos-containing materials.

1.2 RELATED SECTIONS

- .1 Requirements and procedures for asbestos abatement of asbestos-containing materials of the type described within.

1.3 REFERENCES

- .1 O. Reg. 278/05, Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations.
- .2 A Guide to the Regulations respecting Asbestos on Construction Projects and in Buildings and Repair Operations released in November 2007,
<http://www.labour.gov.on.ca/english/hs/asbestos/index.html>.
- .3 O. Reg. 490/09, Designated Substances.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.205-94, Sealer for Application to Asbestos-Fibre-Releasing Materials.

- .5 Department of Justice Canada
 - .1 Canadian Environmental Protection Act (CEPA), 1999.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (MSDS).
- .7 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).
- .8 Underwriters' Laboratories of Canada (ULC).
- .9 U.S. Department of Health and Human Services/Centers for Disease Control and Prevention (CDC)/National Institute for Occupational Safety and Health (NIOSH).
 - .1 NIOSH 94-113-August 1994, NIOSH Manual of Analytical Methods (NMAM), 4th Edition.
- .10 U.S. Department of Labour - Occupational Safety and Health Administration - Toxic and Hazardous Substances.
 - .1 29 CFR 1910.1001-2001, Asbestos Regulations.

1.4 DEFINITIONS

- .1 Airlock: system for permitting ingress or egress without permitting air movement between contaminated area and uncontaminated area, typically consisting of two curtained doorways at least 2 m apart.
- .2 Amended Water: water with a non-ionic surfactant wetting agent added to reduce water tension to allow wetting of fibres.
- .3 Asbestos-Containing Materials (ACMs): materials that contain 0.5 per cent or more asbestos by dry weight and are identified under Existing Conditions including fallen materials and settled dust.
- .4 Asbestos Work Areas: area where work takes place which will, or may disturb ACMs.
- .5 Authorized Visitors: Owner's Representatives or designated representatives, and representatives of regulatory agencies.
- .6 Competent worker person: in relation to specific work, means a worker who:
 - .1 Is qualified because of knowledge, training and experience to perform the work.
 - .2 Is familiar with the provincial and federal laws and with the provisions of the regulations that apply to the work.
 - .3 Has knowledge of all potential or actual danger to health or safety in the work.
- .7 Curtained doorway: arrangement of closures to allow ingress and egress from one room to another while permitting minimal air movement between rooms, typically constructed as follows:

- .1 Place two overlapping sheets of polyethylene over existing or temporarily framed doorway, secure each along top of doorway, secure vertical edge of one sheet along one vertical side of doorway, and secure vertical edge of other sheet along opposite vertical side of doorway.
- .2 Reinforce free edges of polyethylene with duct tape and weight bottom edge to ensure proper closing.
- .3 Overlap each polyethylene sheet at openings not less than 1.5 m on each side.
- .8 DOP Test: testing method used to determine integrity of Negative Pressure unit using dioctyl phthalate (DOP) HEPA-filter leak test.
- .9 Friable Materials: material that when dry can be crumbled, pulverized or powdered by hand pressure and includes such material that is crumbled, pulverized or powdered.
- .10 Glove Bag: prefabricated glove bag as follows:
 - .1 Minimum thickness 0.25 mm (10 mil) polyvinyl-chloride bag.
 - .2 Integral 0.25 mm (10 mil) thick polyvinyl-chloride gloves and elastic ports.
 - .3 Equipped with reversible double pull double throw zipper on top and at approximately mid-section of the bag.
 - .4 Straps for sealing ends around pipe.
- .11 HEPA vacuum: High Efficiency Particulate Air filtered vacuum equipment with a filter system capable of collecting and retaining fibres greater than 0.3 microns in any direction at 99.97% efficiency.
- .12 Negative pressure: system that extracts air directly from work area, filters such extracted air through High Efficiency Particulate Air filtering system, and discharges this air directly outside work area to exterior of building.
 - .1 System to maintain minimum pressure differential of 5 Pa relative to adjacent areas outside of work areas, be equipped with alarm to warn of system breakdown, and be equipped with instrument to continuously monitor and automatically record pressure differences.
- .13 Non-Friable Materials: material that when dry cannot be crumbled, pulverized or powdered by hand pressure.
- .14 Occupied Areas: any area of building or work site that is outside Asbestos Work Area.
- .15 Polyethylene sheeting sealed with tape: polyethylene sheeting of type and thickness specified sealed with tape along edges, around penetrating objects, over cuts and tears, and elsewhere as required to provide continuous polyethylene membrane to protect underlying surfaces from water damage or damage by sealants, and to prevent escape of asbestos fibres through sheeting into clean area.
- .16 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must be appropriate capacity for scope of work.

1.5 SUBMITTALS

- .1 Submittals in accordance with applicable Sections.
- .2 Before beginning work:
 - .1 Obtain from appropriate agency and submit to Owner's Representative necessary permits for transportation and disposal of asbestos waste. Ensure that dump operator is fully aware of hazardous nature of material being dumped, and proper methods of disposal. Submit proof satisfactory to Owner's Representative that suitable arrangements have been made to receive and properly dispose of asbestos waste.
 - .2 Submit proof satisfactory to Owner's Representative that all asbestos workers have received appropriate training and education by a competent person on hazards of asbestos exposure, good personal hygiene, entry and exit from Asbestos Work Area, aspects of work procedures and protective measures while working in Asbestos Work Areas, and the use, cleaning and disposal of respirators and protective clothing. Submit proof of attendance in form of certificate.
 - .3 Ensure supervisory personnel have attended asbestos abatement course, of not less than two days duration, approved by Owner's Representative. Submit proof of attendance in form of certificate. Minimum of one Supervisor for every ten workers.
 - .4 Submit layout of proposed enclosures and decontamination facilities to Owner's Representative for review.
 - .5 Submit documentation including test results for sealer proposed for use.
 - .6 Submit Provincial/Territorial and/or local requirements for Notice of Project form.
 - .7 Submit proof of Contractor's Asbestos Liability Insurance.
 - .8 Submit proof satisfactory to Owner's Representative that employees have respirator fitting and testing. Workers must be fit tested (irritant smoke test) with respirator that is personally issued.
 - .9 Submit Workplace Safety and Insurance Board status and transcription of insurance.
 - .10 Submit documentation including test results, fire and flammability data, and Material Safety Data Sheets (MSDS) for chemicals or materials including but not limited to following:
 - .1 Encapsulants.
 - .2 Amended water.
 - .3 Slow-drying sealer.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements: comply with Federal, Provincial/Territorial and local requirements pertaining to asbestos, provided that in case of conflict among those requirements or with these specifications more stringent requirement applies. Comply with regulations in effect at time work is performed.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with applicable Sections.
 - .2 Safety Requirements: worker and visitor protection.

- .1 Protective equipment and clothing to be worn by workers while in Asbestos Work Area includes:
 - .1 Air purifying full face-mask respirator, powered air purifying respirator (PAPR), or supplied air respirator with N-100, R-100 or P-100 particulate filter, personally issued to worker and marked as to efficiency and purpose, suitable for protection against asbestos and acceptable to Provincial Authority having jurisdiction. The respirator to be fitted so that there is an effective seal between the respirator and the worker's face, unless the respirator is equipped with a hood or helmet. The respirator to be cleaned, disinfected and inspected after use on each shift, or more often if necessary, when issued for the exclusive use of one worker, or after each use when used by more than one worker. The respirator to have damaged or deteriorated parts replaced prior to being used by a worker; and, when not in use, to be stored in a convenient, clean and sanitary location. The employer to establish written procedures regarding the selection, use and care of respirators, and a copy of the procedures to be provided to and reviewed with each worker who is required to wear a respirator. A worker not to be assigned to an operation requiring the use of a respirator unless he or she is physically able to perform the operation while using the respirator.
 - .2 Disposable type protective clothing that does not readily retain or permit penetration of asbestos fibres. Protective clothing to be provided by the employer and worn by every worker who enters the work area, and the protective clothing to consist of a head covering and full body covering that fits snugly at the ankles, wrists and neck, in order to prevent asbestos fibres from reaching the garments and skin under the protective clothing. It includes suitable footwear, and it to be repaired or replaced if torn.

Requirements for each worker:

 - .1 Remove street clothes in clean change room and put on respirator with new filters or reusable filters that have been tested as satisfactory, clean coveralls and head covers before entering Equipment and Access Rooms or Asbestos Work Area. Store street clothes, uncontaminated footwear, towels, and similar uncontaminated articles in clean change room.
 - .2 Remove gross contamination from clothing before leaving work area then proceed to Equipment and Access Room and remove clothing except respirators. Place contaminated work suits in receptacles for disposal with other asbestos - contaminated materials. Leave reusable items except respirator in Equipment and Access Room. Still wearing the respirator proceed naked to showers. Using soap and water wash body and hair thoroughly. Clean outside of respirator with soap and water while showering; remove respirator; remove filters and wet them and dispose of filters in container provided for purpose; and wash and rinse inside of respirator. When not in use in work area, store work footwear in Equipment and Access Room. Upon completion of asbestos abatement, dispose of footwear as contaminated waste

- or clean thoroughly inside and out using soap and water before removing from work area or from Equipment and Access Room.
- .3 After showering and drying off, proceed to clean change room and dress in street clothes at end of each day's work, or in clean coveralls before eating, smoking, or drinking. If re-entering work area, follow procedures outlined in paragraphs above.
- .4 Enter unloading room from outside dressed in clean coveralls to remove waste containers and equipment from Holding Room of Container and Equipment Decontamination Enclosure system. Workers must not use this system as means to leave or enter work area.
- .2 Eating, drinking, chewing, and smoking are not permitted in Asbestos Work Area.
- .3 Ensure workers are fully protected with respirators and protective clothing during preparation of system of enclosures prior to commencing actual asbestos abatement.
- .4 Provide and post in Clean Change Room and in Equipment and Access Room the procedures described in this Section, in both official languages.
- .5 Ensure that no person required to enter an Asbestos Work Area has facial hair that affects seal between respirator and face.
- .6 Visitor Protection:
 - .1 Provide protective clothing and approved respirators to Authorized Visitors to work areas.
 - .2 Instruct Authorized Visitors in the use of protective clothing, respirators and procedures.
 - .3 Instruct Authorized Visitors in proper procedures to be followed in entering into and exiting from Asbestos Work Area.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with applicable Sections.
- .2 Remove from site and dispose of 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 the contractor's Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers in accordance with the contractor's Waste Management Plan.
- .5 Place materials defined as hazardous or toxic in designated containers.
- .6 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, Regional and Municipal regulations.
- .7 Fold up metal banding, flatten and place in designated area for recycling.

- .8 Disposal of asbestos waste generated by removal activities must comply with Federal, Provincial, Territorial and Municipal regulations. Dispose of asbestos waste in sealed double thickness 0.152 mm thick (6 mil) bags or leak proof drums. Label containers with appropriate warning labels.
- .9 Provide manifests describing and listing waste created. Transport containers by approved means to licensed landfill for burial.

1.8 EXISTING CONDITIONS

- .1 Information pertaining to ACM to be handled, removed, or otherwise disturbed and disposed of during this project is bound into this specification.
- .2 Notify Owner's Representative of suspect asbestos containing material discovered during Work and not apparent from drawings, specifications, or report pertaining to Work. Do not disturb such material until instructed by Owner's Representative.

1.9 SCHEDULING

- .1 Not later than ten (10) days before beginning Work on this Project notify following in writing:
 - .1 Appropriate Regional or Zone Director of Medical Services Branch, Health Canada.
 - .2 Regional Office of Labour Canada.
 - .3 Provincial/Territorial, Department of Labour.
 - .4 Disposal Authority.
- .2 Inform sub-trades of presence of asbestos containing materials identified in Existing Conditions.
- .3 Submit to Owner's Representative copy of notifications prior to start of Work.
- .4 Hours of Work: perform work involving abatement as per agreement with Owner's Representative.

1.10 OWNER'S INSTRUCTIONS

- .1 Before beginning Work, provide to Owner's Representative satisfactory proof that every worker has had instruction and training in hazards of asbestos exposure, in personal hygiene including dress and showers, in entry and exit from Asbestos Work Area, in aspects of work procedures including glove bag procedures, and in use, cleaning, and disposal of respirators and protective clothing.
- .2 Instruction and training related to respirators includes, at minimum:
 - .1 Proper fitting of equipment.
 - .2 Inspection and maintenance of equipment.
 - .3 Disinfecting of equipment.
 - .4 Limitations of equipment.
- .3 Instruction and training must be provided by competent, qualified person.

- .4 Supervisory personnel to complete required training.

PART 2 Products

2.1 MATERIALS

- .1 Polyethylene: minimum 0.15 mm thick unless otherwise specified; in sheet size to minimize joints.
- .2 FR polyethylene: minimum 0.15 mm thick, woven fibre reinforced fabric bonded both sides with polyethylene.
- .3 Tape: fibreglass-reinforced duct tape suitable for sealing polyethylene under both dry conditions and wet conditions using amended water.
- .4 Wetting agent: 50% polyoxyethylene ester and 50% polyoxyethylene ether, or other material approved by Owner's Representative, mixed with water in concentration to provide adequate penetration and wetting of asbestos-containing material.
- .5 Waste Containers: contain waste in two separate containers.
 - .1 Inner container: 0.15 mm thick sealable polyethylene bag, or where glove bag method is used, glove bag itself.
 - .2 Outer container: sealable metal or fibre type where there are sharp objects included in waste material; otherwise outer container may be sealable metal or fibre type or second 0.15 mm thick sealable polyethylene bag.
 - .3 Labelling requirements: affix preprinted cautionary asbestos warning, in both official languages, that is visible when ready for removal to disposal site. Label containers in accordance with Asbestos Regulations. Label in both official languages.
- .6 Tape: tape suitable for sealing polyethylene to surfaces under both dry and wet conditions using amended water.
- .7 Slow-drying sealer: non-staining, clear, water-dispersible type that remains tacky on surface for at least 8 hours and designed for purpose of trapping residual asbestos fibres.
- .8 Sealer: flame spread and smoke developed rating less than 50.
- .9 Encapsulants: Type conforming to CAN/CGSB-1.205 and approved by the Fire Commissioner of Canada.
- .10 Sprayed fireproofing: ULC labelled and listed asbestos-free to provide degree of fire or thermal protection required in accordance with applicable Sections.

PART 3 Execution

3.1 Preparation

- .1 Do construction occupational health and safety in accordance with applicable Sections.
- .2 Work Areas:
 - .1 Shut off and isolate air handling and ventilation systems to prevent fibre dispersal to other building areas during work phase. Conduct smoke tests to ensure that duct work is airtight. Seal and caulk joints and seams of active return air ducts within Asbestos Work Area.
 - .2 Preclean moveable furniture within proposed work areas using HEPA vacuum and remove from work areas.
 - .3 Preclean fixed casework, plant, and equipment within proposed work areas, using HEPA vacuum and cover with polyethylene sheeting sealed with tape.
 - .4 Clean proposed work areas using, where practicable, HEPA vacuum cleaning equipment. If not practicable, use wet cleaning method. Do not use methods that raise dust, such as dry sweeping, or vacuuming using other than HEPA vacuum equipment.
 - .5 The spread of dust from the work area to be prevented by:
 - .1 Using enclosures of polyethylene or other suitable material that is impervious to asbestos (including, if the enclosure material is opaque, one or more transparent window areas to allow observation of the entire work area from outside the enclosure), if the work area is not enclosed by walls.
 - .2 Using curtains of polyethylene sheeting or other suitable material that is impervious to asbestos, fitted on each side of each entrance or exit from the work area.
 - .6 Put negative pressure system in operation and operate continuously from time first polyethylene is installed to seal openings until final completion of work including final cleanup. Provide continuous monitoring of pressure difference using automatic recording instrument. The system to maintain a negative air pressure of 5 Pa (0.02 inches) of water, relative to the area outside the enclosed area. The system to be inspected and maintained by a competent person prior each use to ensure that there is no air leakage, and if the filter is found to be damaged or defective, it to be replaced before the ventilation system is used.
 - .7 Seal off openings such as corridors, doorways, windows, skylights, ducts, grilles, and diffusers, with polyethylene sheeting sealed with tape.
 - .8 Cover floor and wall surfaces with polyethylene sheeting sealed with tape. Use one layer of FR polyethylene on floors. Cover floors first so that polyethylene extends at least 300 mm up walls then cover walls to overlap floor sheeting.
 - .9 Build airlocks at entrances to and exits from work areas so that work areas are always closed off by one curtained doorway when workers enter or exit.
 - .10 At each access to work areas install warning signs in both official languages in upper case "Helvetica Medium" letters reading as follows where number in parentheses indicates font size to be used: "CAUTION ASBESTOS HAZARD AREA (25 mm) NO UNAUTHORIZED ENTRY (19 mm) WEAR ASSIGNED PROTECTIVE EQUIPMENT"

- (19 mm) BREATHING ASBESTOS DUST MAY CAUSE SERIOUS BODILY HARM (7 mm)".
- .11 After work area isolation, remove heating, ventilating, and air conditioning filters, pack in sealed plastic bags 0.15 mm minimum thick and treat as contaminated asbestos waste. Remove ceiling - mounted objects such as lights, partitions, other fixtures not previously sealed off, and other objects that interfere with asbestos removal, as directed by Owner's Representative. Use localized water spraying during fixture removal to reduce fibre dispersal.
 - .12 Maintain emergency and fire exits from work areas, or establish alternative exits satisfactory to Fire Commissioner of Canada and Provincial/Territorial Fire Marshall Authority having jurisdiction.
 - .13 Where application of water is required for wetting asbestos containing materials, shut off electrical power, provide 24 volt safety lighting and ground fault interrupter circuits on power source for electrical tools, in accordance with applicable CSA Standard. Ensure safe installation of electrical lines and equipment.
 - .14 After preparation of work areas and Decontamination Enclosure Systems, remove designated asbestos containing ceiling tiles within work areas progressively and carefully, clean using HEPA vacuum and damp sponge, wrap clean panels in 0.10 mm minimum thick polyethylene, and dispose of as contaminated waste. Clean "T" grid suspension system within work areas using wet sponge, disconnect grid from hangers, wrap grid members in 0.10 mm minimum thick polyethylene and store in building as directed by Owner's Representative.
 - .15 After preparation of work areas and Decontamination Enclosure Systems, remove plaster ceilings, including lath, furring, channels, hangers, wires, clips, and dispose of as contaminated waste in specified containers. Spray asbestos debris and immediate work area with amended water to reduce dust, as work progresses.
 - .16 After preparation of work areas and Decontamination Enclosure Systems, for the removal of all other asbestos containing materials, remove within work area and dispose of as contaminated waste in specified containers. Spray asbestos debris and immediate work area with amended water to reduce dust, as work progresses.
- .3 Worker Decontamination Enclosure System:
- .1 Worker Decontamination Enclosure System includes Equipment and Access Room, Shower Room, and Clean Room, as follows:
 - .1 Equipment and Access Room: build Equipment and Access Room between Shower Room and work areas, with two curtained doorways, one to Shower Room and one to work areas. Install portable toilet, waste receptor, and storage facilities for workers' shoes and protective clothing to be rework in work areas. Build Equipment and Access Room large enough to accommodate specified facilities, other equipment needed, and at least one worker allowing him /her sufficient space to undress comfortably.
 - .2 Shower Room: build Shower Room between Clean Room and Equipment and Access Room, with two curtained doorways, one to Clean Room and one to Equipment and Access Room. Provide one shower for every five workers. Provide constant supply of hot and cold or warm water. Provide piping and connect to water sources and drains. Pump waste water through 5 micrometre

filter system acceptable to Owner's Representative before directing into drains. Provide soap, clean towels, and appropriate containers for disposal of used respirator filters.

- .3 Clean Room: build Clean Room between Shower Room and clean areas outside of enclosures, with two curtained doorways, one to outside of enclosures and one to Shower Room. Provide lockers or hangers and hooks for workers' street clothes and personal belongings. Provide storage for clean protective clothing and respiratory equipment. Install mirror to permit workers to fit respiratory equipment properly.

.4 Container and Equipment Decontamination Enclosure System:

- .1 Container and Equipment Decontamination Enclosure System consists of Staging Area within work area, Washroom, Holding Room, and Unloading Room. Purpose of system is to provide means to decontaminate waste containers, scaffolding, waste and material containers, vacuum and spray equipment, and other tools and equipment for which Worker Decontamination Enclosure System is not suitable.

- .1 Staging Area: designate Staging Area in work area for gross removal of dust and debris from waste containers and equipment, labelling and sealing of waste containers, and temporary storage pending removal to Washroom. Equip Staging Area with curtained doorway to Washroom.
- .2 Washroom: build Washroom between Staging Area and Holding Room with two curtained doorways, one to Staging Area and one to Holding Room. Provide high - pressure low - volume sprays for washing of waste containers and equipment. Pump waste water through 5 micrometre filter system before directing into drains. Provide piping and connect to water sources and drains.
- .3 Holding Room: build Holding Room between Washroom and Unloading Room, with two curtained doorways, one to Washroom and one to Unloading Room. Build Holding Room sized to accommodate at least two waste containers and largest item of equipment used.
- .4 Unloading Room: build Unloading Room between Holding Room and outside, with two curtained doorways, one to Holding Room and one to outside.

.5 Construction of Decontamination Enclosures:

- .1 Build suitable framing for enclosures, or use existing rooms where convenient, and line with polyethylene sheeting sealed with tape. Use two layers of FR polyethylene on floors.
- .2 Build curtained doorways between enclosures so that when people move through or when waste containers and equipment are moved through doorway, one of two closures comprising doorway always remains closed.

.6 Separation of Work Areas from Occupied Areas:

- .1 Separate parts of building required to remain in use from parts of building used for asbestos abatement by means of airtight barrier system constructed as follows:
 - .1 Build suitable floor to ceiling lumber or metal stud framing, cover with polyethylene sheeting sealed with tape, and apply 9 mm minimum thick plywood. Seal joints between plywood sheets and between plywood and adjacent materials with surface film forming type sealer, to create airtight barrier.

- .2 Cover plywood barrier with polyethylene sealed with tape, as specified for work areas.
- .7 Maintenance of Enclosures:
 - .1 Maintain enclosures in tidy condition.
 - .2 Ensure that barriers and polyethylene linings are effectively sealed and taped. Repair damaged barriers and remedy defects immediately upon discovery.
 - .3 Visually inspect enclosures at beginning of each working period.
 - .4 Use smoke methods to test effectiveness of barriers when directed by Owner's Representative.
- .8 Do not begin Asbestos Abatement work until:
 - .1 Arrangements have been made for disposal of waste.
 - .2 For wet stripping techniques, arrangements have been made for containing, filtering, and disposal of waste water.
 - .3 Work areas and decontamination enclosures and parts of building required to remain in use are effectively segregated.
 - .4 Tools, equipment, and materials waste containers are on hand.
 - .5 Arrangements have been made for building security.
 - .6 Warning signs are displayed where access to contaminated areas is possible.
 - .7 Notifications have been completed and other preparatory steps have been taken

3.2 SUPERVISION

- .1 Minimum of one Supervisor for every ten workers is required.
- .2 Approved Supervisor must remain within Asbestos Work Area during disturbance, removal, or other handling of asbestos containing materials.

3.3 ASBESTOS REMOVAL

- .1 Before removing asbestos:
 - .1 Prepare site.
 - .2 Spray asbestos material with water containing specified wetting agent, using airless spray equipment capable of providing "mist" application to prevent release of fibres. Saturate asbestos material sufficiently to wet it to substrate without causing excess dripping. Spray asbestos material repeatedly during work process to maintain saturation and to minimize asbestos fibre dispersion.
- .2 Remove saturated asbestos material in small sections. Do not allow saturated asbestos to dry out. As it is being removed pack material in sealable plastic bags 0.15 mm minimum thick and place in labelled containers for transport.
- .3 Seal filled containers. Clean external surfaces thoroughly by wet sponging. Remove from immediate working area to Staging Area. Clean external surfaces thoroughly again by wet sponging before moving containers to decontamination Washroom. Wash containers thoroughly

- in decontamination Washroom, and store in Holding Room pending removal to Unloading Room and outside. Ensure that containers are removed from Holding Room by workers who have entered from uncontaminated areas dressed in clean coveralls.
- .4 After completion of stripping work, wire brushed and wet sponged surfaces from which asbestos has been removed to remove visible material. During this work keep surfaces wet.
 - .5 Where Owner's Representative decides complete removal of asbestos-containing material is impossible due to obstructions such as structural members or major service elements, and provides written direction, encapsulate material as follows:
 - .1 Apply surface film forming type sealer to provide dry film thickness over sprayed asbestos surfaces. Apply using airless spray equipment to avoid blowing off fibres. Apply penetrating type sealer to penetrate existing sprayed asbestos surfaces uniformly to substrate.
 - .6 After wire brushing and wet sponging to remove visible asbestos, and after encapsulating asbestos containing material impossible to remove, wet clean entire work area including Equipment and Access Room, and equipment used in process. After 24 hour period to allow for dust settling, wet clean these areas and objects again. During this settling period no entry, activity, or ventilation will be permitted. After second 24 hour period under same conditions, clean these areas and objects again using HEPA vacuum followed by wet cleaning. After inspection by Owner's Representative apply continuous coat of slow drying sealer to surfaces of work area. Allow at least 16 hours with no entry, activity, ventilation, or disturbance other than operation of negative pressure units during this period.
 - .7 Work is subject to visual inspection and air monitoring. Contamination of surrounding areas indicated by visual inspection or air monitoring will require complete enclosure and clean-up of affected areas.
 - .8 Cleanup:
 - .1 Frequently during Work and immediately after completion of work, clean up dust and asbestos containing waste using HEPA vacuum or by damp mopping.
 - .2 Place dust and asbestos containing waste in sealed dust tight waste bags. Treat drop sheets and disposable protective clothing as asbestos waste and wet and fold to contain dust and then place in waste bags.
 - .3 Immediately before their removal from Asbestos Work Area and disposal, clean each filled waste bag using damp cloths or HEPA vacuum and place in second clean waste bag.
 - .4 Seal and remove double bagged waste from site. Dispose of in accordance with requirements of Provincial/Territorial and Federal authority having jurisdiction. Supervise dumping and ensure that dump operator is fully aware of hazardous nature of material to be dumped and that guidelines and regulations for asbestos disposal are followed.
 - .5 Perform final thorough clean-up of Asbestos Work Areas and adjacent areas affected by Work using HEPA vacuum.

3.4 FINAL CLEANUP

- .1 Following cleaning specified above, and when air sampling shows that asbestos levels on both sides of seals do not exceed 0.01 fibres/cc as determined by membrane filter method at 400-500X magnification phase contrast illumination, as described in NIOSH Method 94-113 or equivalent, proceed with final cleanup.
- .2 Remove polyethylene sheet by rolling it away from walls to centre of work area. Vacuum visible asbestos containing particles observed during cleanup, immediately, using HEPA vacuum equipment.
- .3 Place polyethylene seals, tape, cleaning material, clothing, and other contaminated waste in plastic bags and sealed labelled waste containers for transport.
- .4 Include in clean-up Work areas, Equipment and Access Room, Washroom, Shower Room, and other contaminated enclosures.
- .5 Include in clean-up sealed waste containers and equipment used in Work and remove from work areas, via Container and Equipment Decontamination Enclosure System, at appropriate time in cleaning sequence.
- .6 Conduct final check to ensure that no dust or debris remains on surfaces as result of dismantling operations and carry out air monitoring again to ensure that asbestos levels in building do not exceed 0.01 fibres/cc. Repeat cleaning using HEPA vacuum equipment, or wet cleaning methods where feasible, in conjunction with sampling until levels meet this criteria.
- .7 As work progresses, and to prevent exceeding available storage capacity on site, remove sealed and labelled containers containing asbestos waste and dispose of to authorized disposal area in accordance with requirements of disposal authority. Ensure that each shipment of containers transported to dump is accompanied by Contractor's representative to ensure that dumping is done in accordance with governing regulations.

3.5 RE-ESTABLISHMENT OF OBJECTS AND SYSTEMS

- .1 When cleanup is complete:
 - .1 Re-establish objects and furniture moved to temporary locations in course of Work, in their proper positions.
 - .2 Re-secure mounted objects removed in course of Work in their former positions.
 - .3 Re-establish mechanical and electrical systems in proper working order. Install new filters.
 - .4 Repair or replace objects damaged in the course of Work, as directed by Owner's Representative.

3.6 AIR MONITORING

- .1 From beginning of Work until completion of cleaning operations, Owner's Representative may take air samples on daily basis outside of work area enclosure in accordance with Health Canada recommendations.

- .1 Contractor will be responsible for monitoring inside enclosure in accordance with applicable Provincial/Territorial Occupational Health and Safety Regulations.
- .2 Use results of air monitoring inside work area to establish type of respirators to be used. Workers may be required to wear sample pumps for up to full-shift periods.
 - .1 If fibre levels are above safety factor of respirators in use, stop abatement, apply means of dust suppression, and use higher safety factor in respiratory protection for persons inside enclosure.
 - .2 If air monitoring shows that areas outside work area enclosures are contaminated, enclose, maintain and clean these areas, in same manner as that applicable to work areas.
- .3 During course of Work, Owner's Representative to measure fibre content of air outside work areas by means air samples analyzed by Phase Contrast Microscopy (PCM).
 - .1 Stop Work when PCM measurements exceed 0.05 f/cc and correct procedures.
- .4 Final air monitoring to be conducted as follows: After Asbestos Work Area has passed visual inspection and acceptable coat of lock-down agent has been applied to surfaces within enclosure, and appropriate setting period has passed, Owner's Representative may perform air monitoring within Asbestos Work Area by aggressive methods, where provincial regulations require.
 - .1 Final air monitoring results must show fibre levels of less than 0.01 f/cc.
 - .2 If air monitoring results show fibre levels in excess of 0.01 f/cc, re-clean work area and apply another acceptable coat of lock-down agent to surfaces.
 - .3 Repeat as necessary until fibre levels are less than 0.01 f/cc.

3.7 INSPECTION

- .1 Perform inspection of Asbestos Work Area to confirm compliance with specification and governing authority requirements. Deviations from these requirements that have not been approved in writing by Owner's Representative may result in Work stoppage, at no cost to Owner.
- .2 Owner's Representative will inspect Work for:
 - .1 Adherence to specific procedures and materials.
 - .2 Final cleanliness and completion.
 - .3 No additional costs will be allowed by Contractor for additional labour or materials required to provide specified performance level.
- .3 When asbestos leakage from Asbestos Work Area has occurred or is likely to occur Owner's Representative may order Work shutdown.
 - .1 No additional costs will be allowed by Contractor for additional labour or materials required to provide specified performance level.

END OF SECTION

Part-1 General

1.1 SECTION INCLUDES

- .1 Labour, Products, equipment and services necessary for concrete block masonry Work in accordance with the Contract Documents.

1.2 REFERENCES

- .1 ASTM A82/A82-M, Specification for Steel Wire, Plain, for Concrete Reinforcement.
- .2 ASTM C207, Specification for Hydrated Lime for Masonry Purposes.
- .3 ASTM C516, Standard Specification for Vermiculite Loose Fill Thermal Insulation.
- .4 CAN/CSA A23.1-M, Concrete Materials and Methods of Concrete Construction.
- .5 CSA A165 Series, CSA Standards on Concrete Masonry Units.
- .6 CSA A179, Mortar and Grout for Unit Masonry.
- .7 CSA A370, Connectors for Masonry.
- .8 CSA A371, Masonry Construction for Buildings.
- .9 CAN/CSA A3000, Cementitious Materials Compendium.
- .10 CAN/CSA G30.18-M, Billet-Steel Bars for Concrete Reinforcement.
- .11 CSA S304.1, Design of Masonry Structures.

1.3 SUBMITTALS

- .1 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 00 10 - General Requirements.
 - .2 Wall sections and details, reinforcing and anchors, special detailing, patterning, and locations of control joints.
- .2 Samples:
 - .1 Submit samples in accordance with Section 01 00 10 - General Requirements.
 - .2 Submit samples of each type and colour of masonry unit used prior to placing order.
 - .3 Submit samples of masonry anchors, and ties.
 - .4 Submit 250 x 200 mm samples of dampproof course.
- .3 Quality control submittals:
 - .1 Submit manufacturer's certificates stating that materials supplied are in

accordance with this Specification.

1.4 QUALITY ASSURANCE

- .1 Provide plain and reinforced masonry in accordance with CSA A370, CSA A371, and CSA S304.1.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle Products in accordance with the Conditions of the Contract and as specified in this Section.
- .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 intermixture 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 CAN3-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 on it. 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.

1.6 SITE CONDITIONS

- .1 Do not lay masonry when ambient temperature is at or below 5 degrees Celsius unless temporary protection and heating is maintained until mortar has completely set. Supply and install temporary protection and heating for installed, uncured unit masonry when ambient conditions are at, below, or are likely to go below 5 degrees Celsius, until 7 Days after installation.
- .2 Conform to cold weather masonry requirements of CAN3-A371 and Recommended Practices for Cold Weather Masonry Construction by Ontario Masonry Contractors' Association.

Part-2 Products

2.1 MASONRY UNITS

- .1 Concrete Block Units: Normal weight units, CSA A165 Series, 240 mm thick unless otherwise indicated on Contract Drawing, classifications as follows:
 - .1 H/15/A/M.
 - .2 S/15/A/M.
 - .3 Sc/15/A/M.
- .2 Concrete Block Units: Lightweight units, CSA A165 Series, 190 mm thick unless otherwise indicated on Contract Drawing, classifications as follows:
 - .1 H/15/D/M.
 - .2 S/15/D/M.
 - .3 Sc/15/D/M.
- .3 Special Shapes: 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, solid block where noted, concrete block lintels over openings in concrete block walls and any additional special shapes as indicated.
- .4 Obtain each masonry unit type from same manufacturer. Supply and install units of uniform texture and colour for each kind required.
- .5 Supply masonry units with exposed surfaces free of cracks, chips, blemishes, and broken corners.

2.2 ACCESSORIES

- .1 Wire reinforcement: CAN3-A370, CAN3 A371, and ASTM A82/A82-M, hot dip galvanized, truss type; 'Blok-Trus BL30' by Blok-Lok Limited. Products by Dur-O- Wal Ltd. are approved alternatives.
- .2 Connectors: CSA A370 and CSA S304.1.
- .3 Reinforcing steel: CSA G30.18-M, Grade 400, refer to Contract Drawings for number, size, and location.
- .4 Loose steel lintels and lateral support angles: Supplied as part of Work of Section 05 50 00 – Metal Fabrications.
- .5 Granular Insulation: ASTM C516; Expanded exfoliated vermiculite, type II - surface treated to produce water repellency and limit dust. 'Zonolite Masonry Insulation' by Specialty Vermiculite Corporation or approved alternative.
- .6 Dampproof course and flashing: Reinforced SBS rubberized asphalt compound laminated to cross-laminated polyethylene film, 40 mils thick; 'Airshield Thru Wall Flashing' by W.R. Meadows or approved alternative, complete with primer and adhesive recommended by flashing manufacturer.

- .7 Compressible Filler: 75 x 6 mm thick preformed, polyurethane foam; 25V by Emseal Joint Systems Ltd.
- .8 Control Joint Filler: Prefabricated extruded rubber joint to suit wall thickness; RS Series Rubber Control Joint by Blok-Lok or approved alternative.

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 Cement: CAN/CSA A3000, normal Portland, Type GU.
- .4 Hydrated lime: ASTM C207, Type S.
- .5 Masonry aggregate: CSA A179.
- .6 Water: Clean potable, free from deleterious elements and free from salts that can cause efflorescence.
- .7 Concrete fill and grout: 20 Mpa concrete in accordance with CSA A23.1.

Part-3 Execution

3.1 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.

3.2 WORKMANSHIP

- .1 Perform masonry Work in accordance with CAN3 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 Install masonry Work to a plane flatness and exposed end tolerance of 3 mm in 2 400 mm.
- .4 Variation in Alignment from Unit to Adjacent Unit: 1.5 mm maximum.

- .5 Variation of Mortar Joint Thickness: 3 mm every metre.

3.3 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 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.

- .11 Reinforce masonry walls with reinforcing steel as indicated on Drawings. Vertical reinforcing shall be fully grouted in masonry cores with grout.
- .12 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.
- .13 Reinforce joint corners and intersections with strap anchors 400 mm on centres.
- .14 Do not place reinforcement across masonry wythes at control joints.
- .15 Install masonry with 10 mm thick joints unless indicated otherwise. Make vertical and horizontal joints equal and of uniform thickness.
- .16 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. Fill chase and joint with joint filler full height of control joints. Leave a depth of 13 mm for sealing unless otherwise shown.
- .17 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 6 100 mm on centres for exterior walls and 9 150 mm on centres for interior walls.
- .18 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 or anchors shown.
- .19 Do not tooth intersections of walls except as otherwise indicated.
- .20 Coordinate installation of masonry with installation of air barrier and vapour retarder to ensure continuity of these systems.

3.4 DAMPPROOF COURSES

- .1 Install dampproof courses beneath first masonry bearing course on slabs-on-grade. Trim damp proofing to conceal it.
- .2 Lap damp proofing 150 mm and seal in accordance with manufacturer's instructions.
- .3 Before masonry work begins, place specified damp proofing under first course of masonry. Install continuous damp proofing with ends lapped and cut flush with exterior face of wall. Place similar damp proofing over top course.

3.5 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.
- .5 Add admixtures to requirements of manufacturer's instructions.
- .6 Provide uniformity of mix.

3.6 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.

3.7 GRANULAR INSULATION

- .1 Place granular insulation in concrete block cells at height intervals not to exceed 6 m as wall construction proceeds.
- .2 Place insulation to fill cavity before installation of windowsills, through-wall flashing, and other obstructions.
- .3 Affix warning labels to insulation filled walls to indicate presence of loose granular insulation.

3.8 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.
- .3 Install reinforcing steel and concrete fill in block lintels.
- .4 Install loose steel lintels, as indicated in Contract Drawings. Centre over opening width.

3.9 LATERAL SUPPORT ANGLES

- .1 Where non load bearing unit masonry partitions meet structural elements at top of partitions, provide 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 1 200 mm and staggered.

3.10 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 other mechanical and electrical Divisions.
- .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.

3.11 INSTALLATION TOLERANCES

- .1 Planes true to within 3 mm under 3 m straightedge.
- .2 Plumb within 6 mm in 3 m, or in 6 mm in 6 m at external corners, expansion joints, or other conspicuous lines.
- .3 Level within 6 mm in any bay or 6 m maximum distance, and 12 mm in 12 m or more.
- .4 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.

- .5 Opening sizes within 6 mm of designated dimension.
- .6 Column and wall cross-section dimensions within minus 6 mm and plus 12 mm.
- .7 With joints to dimensions indicated, but in no case greater than 12 mm.

3.12 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.

3.13 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.

END OF SECTION

Part-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 A167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
- .5 ASTM A269, Specification for Seamless and Welded Austenitic Stainless Steel Sanitary Tubing for General Service.
- .6 ASTM A276, Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
- .7 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- .8 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .9 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steels.
- .10 CAN/CSA G164-M, Hot Dip Galvanizing of Irregularly Shaped Articles.
- .11 CAN/CSA S16.1-M, Limit States Design of Steel Structures.
- .12 CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.
- .13 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
- .14 CSA W48, Filler Metal and Allied Materials for Metal Arc Welding.
- .15 CSA W59-M, Welded Steel Construction (Metal Arc Welding).
- .16 CAN/CSA W117.2-M, Safety in Welding, Cutting and Allied Processes.
- .17 CAN/CGSB 1.40-M, Primer, Structural Steel, Oil Alkyd Type.

- .18 CGSB 1-GP-181, Organic Zinc Rich Primer.
- .19 CGSB 85-GP-16M, Painting Galvanized Steel.
- .20 NAAMM, The National Association of Architectural Metal Manufacturers.
- .21 Steel Structures Painting Council (SSPC), Steel Structures Painting Manual, Vol.

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 00 10 - General Requirements 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 steel stairs, handrails and railings, splash guards, and metal fabrication items that are required to resist live, dead, lateral, wind, or seismic loads.
 - .2 Review, stamp, and sign shop drawings.
- .2 Workmanship: Fabricate Work of this Section to meet the required class of workmanship indicated below in accordance with AMP 555, Section 8.
 - .1 Class 2: for use on exposed to view (at a distance) fabricated items:
 - .1 Exposed surfaces retain mill marks and moderate irregularities not visible by naked eye at 10 meters. Ensure burrs and sharp edges are filed down or ground off.
 - .2 Exposed welds are ground with uniform sized cove.
 - .3 Minor distortions are permitted.
 - .4 Exposed joints have a maximum gap of 1.5 mm.
- .3 Execute welding by firms certified in accordance with CSA W47.1 Division 01.
 - .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.

Part-2 Products

2.1 MATERIALS

- .1 General:
 - .1 Materials under Work of this Section, including but not limited to, primers and paints are to have low VOC content limits.
 - .2 Wherever possible, metals used in work of this Section are to contain recycled content.
 - .3 Unless detailed or specified in this Section, standard products will be acceptable if construction details and installation meet intent of Drawings and Specifications.
 - .4 Include all materials, products, accessories, and supplementary parts necessary to complete assembly and installation of Work of this Section.
 - .5 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 A167, Type 304, finish to AISI No. 4. Size as shown.
- .5 Stainless Steel Tubing: ASTM A269, Type 304, to AISI No. 4 finish. Size as shown.
- .6 Stainless Steel Shapes: ASTM A276, Type 304, finish to AISI No. 4. Sizes and shapes as shown.
- .7 Protection Posts: ASTM A53/A53-M, Schedule 40 standard weight steel pipe in quantity and sizes shown.
- .8 Steel Bar Grating: Bearing bar sizes and spacing as indicated on drawings. Grating as manufactured by Borden Metal Products Ltd., Fisher & Ludlow Ltd. or McNichols Co.
- .9 Metal Grating Stair Treads: Grating treads with checkered plate nosing. 'Welded Steel Treads' by Fisher & Ludlow Ltd.; Safety Steps' by IKG Borden; or 'Stair Treads' by Amico-ISG.
- .10 Welding Materials: CSA W48 and CSA W59-M.
- .11 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.

- .12 Powder Coat Finish: In accordance with Section 09 96 55.
- .13 Primer Paint: CAN/CGSB-1.40-M or CPMA 1.73a.
- .14 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.
- .15 Galvanized Primer Paint: CGSB 1-GP-181; Organic zinc rich primer. For galvanized fabrications where touchup is to remain unpainted in finished work: Inorganic zinc rich primer, Galvafroid by W.R. Meadows of Canada Ltd.
- .16 Drilled Inserts: Mega by ITW Construction Products or HSL by Hilti Inc. heavy-duty anchors, sizes as shown.

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 metal fabrication items indicated below and items not indicated to be supplied under other Sections. The following items includes miscellaneous and metal fabrication including but not limited to the items listed below.
- .4 Metal Pan Stairs:
 - .1 Fabricate steel channel stringer of size, construction and attachment to structure as shown. Close exposed ends of stringers with 3 mm thick steel closure plates welded to edges of exposed flange edges.
 - .2 Furnish treads, risers and landing permanent metal forms of steel sheet formed as shown; treads to be concrete filled in accordance with Division 3, with bare metal riser incorporating 19 mm dust cove. Fabricate landings for concrete fill of same material as stair treads, unless ribbed metal deck form is shown.
 - .3 Support treads, risers and landings as detailed on reviewed shop drawings.
- .5 Grating Stairs:
 - .1 Fabricate steel channel stringer of size, construction and attachment to structure as shown. Close exposed ends of stringers with 3 mm thick steel closure plates welded to edges of exposed flange edges.
 - .2 Treads and landings: Landings to be fabricated from steel bar grating and stair treads to be one piece grating with checkered plate nosing, landing grating to be same grating type as tread grating.
 - .3 Support treads, risers and landings as detailed on reviewed shop drawings.
- .6 Handrails, 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 to load design of railings be less than 2.2 kN/m horizontally and 1.5 kN/m vertically.
 - .2 Close open ends of steel handrails with 1.9 mm thick closure neatly welded. Fabricate railings, handrails, and guardrails as shown on drawings.
 - .3 Handrail Bracket: Fabricate as shown. After fabrication, galvanized bracket in accordance with CAN/CSA G164-M.
- .7 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.
8. Masonry Lateral Support Angles:
 - .1 Supply only to Section 04 22 00 – Concrete Unit Masonry 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.
9. 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.

- .10 Channel door frames: Structural channel sections, selected for trueness of web and flange, with joints welded and ground smooth. Supply bar stop and bent bar anchors for anchorage to masonry or concrete as required. Fit frames with temporary spreaders to prevent frame from springing out of shape.
- .11 Support framing for accordion folding grilles: Structural channel and angle framing continuously welded and securely anchored to structure above. Design framing and anchorage to support assembly dead loads and live loads, and lateral loads attributable to misuse and vandalism. Finish: Prime painted.
- .12 Bench Supports:
 - .1 Supply only, for installation under work of Section 06 20 00 – Finish Carpentry, bench supports constructed of steel plates of sizes noted. Provide supports at maximum 610 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.
- .13 Steel ladders: Fabricate complete with steel stiffeners, rungs, angle rails, bent plate straps or angle brackets as shown. Ladders in elevator pits to extend 1 220 mm high above finished floor. Provide safety cages around ladders where indicated on Drawings, in accordance with Ministry of Labour requirements.
- 14. Metal Roof Access Stair:
 - .1 Galvanized plank treads with debossed round holes surrounded by perforated buttons to provide non-slip surface.
 - .2 Handrails: As specified in this Section.
- .15 Splash Guards:
 - .1 Provide framing for splash guards at bus wash area.
 - .2 Provide stainless steel framing and supports to accept glazed and plastic panels as required.
 - .3 Glazed and plastic panels: In accordance with Section 08 80 50 - Glazing.
- .16 Exterior Bollards:
 - .1 Provide protection posts as indicated on drawings. Posts to be 250 mm diameter at fuel storage and 200 mm diameter in all other locations with a wall thickness of 8 mm. Place posts into a 1 220 mm foundation with poly sleeve covers, fill with 20 Mpa concrete and round top. Project pipes 1 220 mm above finished grade. Finish prime coat.
 - .2 Finish: Provide paint finish in accordance with Section 09 91 13 – Exterior Painting, colour to be selected by Consultant.
- .17 Interior Bollards:
 - .1 Provide protection posts as indicated on drawings. Posts to be 150 mm diameter with a wall thickness of 8 mm. Secure posts to concrete floor with welded plate and 4 anchor bolts, fill with 20 Mpa concrete and round top. Project pipes 1 220 mm above finished floor. Finish prime coat.

- .2 Finish: Provide paint finish in accordance with Section 09 91 13 – Exterior Painting, colour to be selected by Consultant.
- .18 Canopy Parapet: Provide 18 gauge bent galvanized steel plate metal upstand.
- .19 Vanity counter supports:
 - .1 Provide supports for vanity counters. Construct supports of steel plate as detailed.
 - .2 Provide all drill holes required for concealed anchorage of counters and for anchoring to building structure.
- .20 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 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 to 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, to 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.
 - .1 Paint on dry surfaces, free from rust, scale, grease.
 - .2 Do not paint when temperature is lower than 7 degrees Celsius.
 - .3 Paint items under cover and leave under cover until primer is dry.
 - .4 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. Plug relief vents airtight. After galvanizing, remove plugs, ream holes to proper size and re-tap threads. 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 CAN/CSA G164-M and 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/m² for 6 mm and heavier members 640 g/m².
 - .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.

Part-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.
- .4 Erect rails and handrails in true vertical and horizontal planes, rigid, and free from whip.
- .5 Continuously weld connections for railings, and anchor directly to steel stringers.

3.3 FIELD PAINTING

- .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

Part-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 F1667, Driven Fasteners: Nails, Spikes and Staples.
- .5 CAN/CSA O80 Series M, Wood Preservation.
- .6 CSA O121-M, Douglas Fir Plywood.
- .7 CAN/CSA O141, Softwood Lumber.
- .8 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .9 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 to be 19 percent maximum.
- .5 Each piece of pressure treated lumber and fire-retardant treated lumber to be shop marked with the pressure treatment brand and ULC monogram respectively, in accordance with CAN/CSA O80-M.
- .6 Dimensions of lumber to conform to dressed sizes specified in CAN/CSA-O141 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 to 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.
- .2 Cover materials with tarpaulins or polyethylene sheets to prevent moisture absorption and impairment of structural and aesthetic properties.
- .3 Vent to allow air movement. Tie covering to keep in place.

Part-2 Products

2.1 MATERIALS

- .1 General:
 - .1 Materials used for Work of this Section are to include, but not be limited to the following criteria:
 - .1 Regionally sourced materials.
 - .2 Certified wood.
 - .3 Low VOC content limits.
 - .2 Adhesives - Urea-formaldehyde-free glues.
 - .3 All dimensional lumber and plywood to be FSC certified.
 - .4 All composite wood and/or agrifibre products (including core materials) and adhesives used to fabricate laminated assemblies used in building must not contain added urea-formaldehyde.
 - .5 Material to be sourced regionally from within 800 km of jobsite wherever possible.
- .2 Lumber: Softwood, G4S, moisture content 19 percent or less at time of installation, in accordance with the following:
 - .1 Lumber to be of same species and grade, equally seasoned and to 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 unsanded, T & G, standard construction, laminated with waterproof adhesive, exterior grade, Thickness as indicated on drawings.
- .4 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/ m3 of preservative unless otherwise specified by preservative manufacturer.
- .5 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.
- .6 Fire retardant treatment of lumber and plywood: 'Dricon' fire retardant treatment by Biewer Lumber or approved alternative, conforming to CAN/CSA-O80.20 and CAN/CSA-O80.27 respectively, to provide a flame spread rating of 25 or less in accordance with CAN/ULC-S102.
- .7 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.
- .8 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.

Part-3 Execution

3.1 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.

3.2 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.

3.3 ROOF WOODWORK

- .1 Install continuous wood nailers around roof perimeters, curbs and roof openings larger than 150 x 150 mm, and at edges of insulation as detailed. Install cut cant strips and continuous nailers on copings and curbs as detailed.
- .2 Install wood backing, dressed, tapered and recessed slightly below top surface of roof insulation and roof hopper.
- .3 Fasten roof woodwork at maximum 400 mm on centres in staggered pattern unless noted otherwise.

3.4 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.

3.5 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.

3.6 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

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements.
- .2 Section 06 40 00 - Architectural Woodwork.
- .3 Section 09 91 23 - Interior Painting: Site finishing for finish carpentry.

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)
 - .1 ANSI A208.2-09, Medium Density Fibreboard (MDF) for Interior Applications.
 - .2 ANSI/HPVA HP-1-10, American National Standard for Hardwood and Decorative Plywood.
 - .3 ANSI/BHMA A156.16 Auxiliary Hardware.
 - .4 ANSI/ASME 18.6.1 1981 (R2012) Wood Screws (Inch Series).
- .2 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Architectural Woodwork Institute (AWI)
 - .1 Architectural Woodwork Quality Standards.
- .3 ASTM International
 - .1 ASTM A 153/A 153M-16, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-11.3, Hardboard.
- .5 CSA Group (CSA)
 - .1 CSA O121-08(R2013), Douglas Fir Plywood.
 - .2 CSA O151-09(R2014), Canadian Softwood Plywood.
 - .3 CSA O153-M13, Poplar Plywood.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature, data sheets and catalogue pages for specified products. Include product characteristics, performance criteria, dimensions and profiles, finish and limitations on use.
 - .2 Submit two copies of WHMIS SDS.
- .3 Shop Drawings:
 - .1 Prepare and submit shop drawings in general accordance with AWMAC AWS manual.
 - .2 Indicate profiles and dimensions, assembly techniques, jointing, methods of fastening, terminations and other related details.

- .3 Indicate materials, thicknesses, finishes and hardware.
- .4 Include schedule or key plan.
- .5 Show profiles, elevations and details at scales recommended by AWMAC AWS.
- .6 Where necessary, show location and type of blocking and backing required within supporting assemblies.
- .4 Samples:
 - .1 Submit triplicate 300 mm long representative samples of each typical item of finish carpentry.
 - .1 Standing and running trim: 300 mm long.
 - .2 Panel materials: 300 mm x 300 mm.
 - .2 Shop applied coating samples:
 - .1 For transparent finish, submit triplicate samples of each species and cut of wood veneer to be used, finished to match project sample.
 - .2 For opaque finish, submit triplicate samples for each colour selection, finished to match project sample.
 - .3 Decorative overlaid composite panels, complete with applied edge treatment and corner treatment, minimum 300 mm x 300 mm.
 - .4 Samples for site applied finish:
 - .1 Furnish four samples of each finish carpentry item and composite panel material to Contractor for preparation of site applied finish samples.
 - .5 Submit duplicate samples of each hardware item to be left exposed in final construction. Samples will be returned for incorporation into the work.
- .5 Certifications: submit certificates signed by manufacturer certifying materials comply with specified performance characteristics, physical properties and requirements of referenced standards.
- .6 Test and Evaluation Reports: submit certified test reports for composite wood from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

1.4 QUALITY ASSURANCE

- .1 Perform Work of this Section by finish carpentry contractor with minimum 5 years of current experience and having completed minimum one project in the past 5 years with value within 20% of the cost of the work of this Section.
- .2 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 00 10 - General Requirements.
 - .2 Shop prepare one typical example of each specified item of standing and running trim, wall paneling, stair, ramp, complete with shop applied finishes, and install where directed by Consultant.
 - .3 Allow 24 hours for inspection of mock-up by Consultant before proceeding with Work.
 - .4 When accepted, mock-up will demonstrate minimum standard for Work.
 - .5 Do not proceed with work before receipt of written acceptance of mock-up by Consultant.
 - .6 Accepted mock-up may remain as part of finished work.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with AWS recommendations and as follows.
- .2 Deliver finish carpentry materials only when area of work is enclosed, plaster and concrete work is dry, area is broom clean and site environmental conditions are acceptable for installation.
- .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 Maintain indoor temperature and humidity within range recommended by AWS for location of the Work.
 - .3 Store products on site as specified for minimum 72 hours before installation.
 - .4 Store and protect finish carpentry products from moisture, nicks, scratches, and blemishes.
 - .5 Replace defective or damaged materials with new.
- .4 Waste Management: for packaging and materials, in accordance with Section 01 00 10 - General Requirements.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

- .1 Wood fire rated frames and panels: labelled and listed by an organization accredited by Standards Council of Canada in conformance with CAN4-S104 or NFPA 252 for ratings specified or indicated.
- .2 Provide fire labelled frames for openings requiring fire protection ratings. Test products in conformance with CAN4-S104, or NFPA 252 and listed by nationally recognized agency having factory inspection services.

2.2 QUALITY GRADE

- .1 Provide all materials and perform all work of this Section in accordance with AWMAC AWS Custom Grade, except as follows:
 - .1 Economy Grade: mechanical rooms and utility areas, storage areas, janitor's closets and other service spaces.
 - .2 Premium Grade: lunchrooms, washrooms, change rooms, office spaces, quiet rooms, corridor and vestibule areas.
- .2 In case of conflict between Contract Documents and AWMAC AWS grade requirements, Contract Documents govern.

2.3 MATERIALS

- .1 Softwood and hardwood lumber: Sound lumber to specified AWS grade requirements, kiln-dried to moisture content recommended for location of the Work.
 - .1 Machine stress-rated lumber is acceptable for all purposes.

- .2 MDF (medium density fibreboard) core: to ANSI A208.2, density 769 kg/m³, commercial grade, 19 mm thick unless indicated otherwise.
 - .1 Use moisture resistant MR grade for countertops and splash-backs to receive plumbing fixtures.
- .3 Interior mat-formed wood particleboard: to ANSI/NPA A208.1, industrial grade M-2 or M-3, medium density (640-800 kg/m³), thickness 19 mm unless indicated otherwise.
 - .1 Use moisture resistant grade 2-M-2 or 2-M-3 for countertops and splash-backs to receive plumbing fixtures.
- .4 Douglas fir plywood (DFP): to CSA O121, standard construction.
- .5 Canadian softwood plywood (CSP): to CSA O151, standard construction.
- .6 Hardwood plywood: to ANSI/HPVA HP-1.
- .7 Poplar plywood (PP): to CSA O153, standard construction.
- .8 Hardboard: to CAN/CGSB-11.3.
- .9 Low density fibreboard: to CSA-A247M.

2.4 FASTENINGS

- .1 Provide screws, bolts, expansion shields and other fastening devices required for satisfactory installation.
- .2 Exposed fasteners to match finish of hardware.
- .3 Nails and staples: to ASTM F 1677, galvanized to ASTM A 153/A 153M, stainless steel for exterior work, interior humid areas; plain finish elsewhere.
- .4 Wood screws: to ANSI/ASME 18.6.1, countersunk flush type unless indicated otherwise, in sizes to suit application, galvanized to ASTM A 153/A 153M for exterior work, interior humid areas, electroplated steel, brass, or stainless steel for other locations.
- .5 Splines: wood or metal.

2.5 HARDWARE

- .1 Use one manufacturer's product for all similar items.
- .2 Shelf Hardware: to ANSI/BHMA A156.16.
- .3 Miscellaneous Hardware: to ANSI/BHMA A156.16.
- .4 Hardware fastenings:
 - .1 Supply screws, bolts, expansion shields and other fastening devices required for satisfactory installation of hardware.
 - .2 Exposed fastening devices to match finish of hardware.
 - .3 Use fasteners compatible with material through which they pass.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contract s are acceptable for wood products installation in accordance with AWS tolerances and requirements of Contract Documents.
 - .1 Visually inspect substrate.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 PREPARATION

- .1 Back prime woodwork before installation, to AWS.

3.3 INSTALLATION

- .1 Install items of finish carpentry in accordance with AWMAC AWS grade specified for respective items.
- .2 In case of conflict between Contract Documents and AWS grade requirements, Contract Documents govern.
- .3 Install items of finish carpentry at locations shown on drawings.
 - .1 Position accurately, level, plumb straight.
 - .2 Fasten and anchor securely.
- .4 Scribe and cut as required, fit to abutting walls, and surfaces, fit properly into recesses and to accommodate piping, columns, fixtures, outlets, or other projecting, intersecting or penetrating objects.
- .5 Form joints to conceal shrinkage.

3.4 CONSTRUCTION

- .1 Fastening:
 - .1 Position items of finished carpentry work accurately, level, plumb, true and fasten or anchor securely.
 - .2 Design and select fasteners to suit size and nature of components being joined. Use proprietary devices as recommended by manufacturer.
 - .3 Set finishing nails to receive filler. Where screws are used to secure members, countersink screw in round smooth cut hole and plug with wood plug to match material being secured.
 - .4 Replace items of finish carpentry with damage to wood surfaces including hammer and other bruises.
- .2 Standing and running trim:
 - .1 Butt and cope internal joints of baseboards to make snug, tight, joint. Cut right angle joints of casing and base with mitred joints.

- .2 Fit backs of baseboards and casing snugly to wall surfaces to eliminate cracks at junction of base and casing with walls.
- .3 Make joints in baseboard, where necessary using a 45 degrees scarf type joint.
- .4 Install door and window trim in single lengths without splicing.
- .3 Interior and exterior frames:
 - .1 Set frames with plumb sides and level heads and sills and secure.
- .4 Paneling:
 - .1 Secure paneling and perimeter trim using adhesive recommended for purpose by manufacturer. Fill nail holes caused by temporary fixing with filler matching wood in colour.
 - .2 Secure paneling and perimeter trim using concealed fasteners.
 - .3 Secure paneling and perimeter trim using counter sunk screws plugged with matching wood plugs.
- .5 Stairs and ramps:
 - .1 Install stairs and ramps to location and details as indicated.
- .6 Handrails, wall rails and bumper rails.
 - .1 Install handrails, wall rails and bumper rails in locations indicated.
 - .2 Make joints hair line, dowelled and glued.
 - .3 Install support brackets as indicated.
 - .4 Install brackets at ends and as indicated at intermediate spacings.
 - .5 Secure using counter sunk screws plugged with matching wood plugs.
- .7 Shelving:
 - .1 Install shelving on shelf brackets as indicated.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements.
 - .1 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 01 00 10 - General Requirements.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

3.6 TOUCHUP AND PROTECTION

- .1 Fill and retouch all nicks, chips and scratches in factory finishes and substrate materials to AWS standards. Replace damaged items that cannot be repaired to AWS standards.
- .2 Protect installed products and components from damage during construction.
- .3 Repair damage to adjacent materials caused by finish carpentry installation.
- .4 Leave work to be site finished ready for finishing by Section 09 91 23 - Interior Painting.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements.
- .2 Section 07 92 00 - Joint Sealants: Sealant materials and application.
- .3 Section 09 91 23 - Interior Painting: Field finishing materials and application.

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)
 - .1 ANSI/ASME 18.6.1-1981 (R2012) Wood Screws (Inch Series).
 - .2 ANSI/BHMA A156.9-2010, Cabinet Hardware.
 - .3 ANSI/BHMA A156.11-2014, Cabinet Locks.
 - .4 ANSI/BHMA A156.16-2013, Auxiliary Hardware.
 - .5 ANSI/BHMA A156.18-2012, Materials and Finishes.
 - .6 ANSI/BHMA A156.20-2006, Strap and Tee Hinges and Hasps.
 - .7 ANSI A208.1-09, Particleboard.
 - .8 ANSI A208.2-09, Medium Density Fiberboard (MDF) for Interior Applications.
 - .9 ANSI/HPVA HP-1-10, Standard for Hardwood and Decorative Plywood.
- .2 Architectural Woodwork Manufacturers Association of Canada (AWMAC)
 - .1 Architectural Woodwork Standards (AWMAC AWS), 2014.
- .3 ASTM International (ASTM)
 - .1 ASTM A 153/A 153M-16, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .2 ASTM E 1333-14, Standard Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates From Wood Products Using a Large Chamber.
 - .3 ASTM F 1667-13 Standard Specification for Driven Fasteners: Nails, Spikes and Staples.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-11.3-M87, Hardboard.
 - .2 CAN/CGSB-71.20-M88, Adhesive, Contact, Brushable.
 - .3 CAN/CGSB-71.19-M88, Adhesive, Contact, Sprayable.
- .5 CSA Group (CSA)
 - .1 CSA O121-08(R2013), Douglas Fir Plywood.
 - .2 CSA O151-14, Canadian Softwood Plywood.
 - .3 CSA O153-M1980 (R2014), Poplar Plywood.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).

1.3 PREINSTALLATION MEETING

- .1 Before enclosing framing, convene a meeting of contractor, casework fabricator, casework installer, framing subcontractor and Consultant.
 - .1 Review locations of backing required for casework installation as shown on shop

- drawings and as necessary for installation.
- .2 Review method of attachment for backing to wall system.
- .3 Review coordination with other affected sections.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Prepare and submit material list in accordance with AWMAC AWS, cross-referenced to specifications.
 - .2 Include manufacturer's instructions, printed product literature, data sheets and catalogue pages for all materials and products to be incorporated into architectural wood casework and include product characteristics, performance criteria, dimensions and profiles, finish and limitations on use.
 - .3 Submit two copies of WHMIS SDS.
- .3 Hardware List:
 - .1 Submit hardware list cross-referenced to specifications.
 - .2 Include manufacturer's specification sheets indicating name, model, material, function, finish, BHMA designations and other pertinent information.
- .4 Shop Drawings:
 - .1 Prepare and submit shop drawings in accordance with AWMAC AWS and as follows.
 - .2 Submit two sets of shop drawings for initial review in accordance with requirements of Division 01. Revise as directed, submit six copies for final acceptance and distribution.
 - .3 Indicate details of construction, profiles, jointing, fastening and other related details.
 - .1 Scales: profiles full size, details half full size.
 - .4 Indicate materials, thicknesses, finishes and hardware.
 - .5 Indicate locations of service outlets in casework, typical and special installation conditions, and connections, attachments, anchorage and location of exposed fastenings.
 - .6 Show location on casework elevations of backing required in supporting structure for attachment of casework.
 - .7 Indicate AWMAC AWS quality grade where different from predominant grade specified.
 - .8 Include color schedule of all casework items, including all countertop, exposed, and semi-exposed cabinet finishes, finish material manufacturer, pattern, and color.
 - .9 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario Canada.
- .5 Samples:
 - .1 Prepare and submit samples in accordance with AWMAC AWS and as follows.
 - .2 Apply sample finishes to specified substrate or core material minimum 300 x 300 mm to match designer sample. For veneers with transparent finish submit three samples to illustrate range and colour of grain expected.
 - .3 Shop applied coatings:
 - .1 For transparent finish, submit triplicate samples of each species and cut of wood to be used, finished to match project sample.
 - .2 For opaque finish, submit triplicate samples for each colour selection, finished to match project sample.
 - .4 Submit duplicate samples of laminated plastic for each specified colour selection.

- .5 Submit duplicate samples of laminated plastic joints, edging, cutouts, and post-formed profiles.
- .6 Furnish four samples of each lumber and composite panel material to Contractor for preparation of site applied finish samples in accordance with Section 09 91 23 Interior Painting.
- .7 Certifications: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .8 Submit statement of experience and qualifications of architectural wood casework fabricator.

1.5 QUALITY ASSURANCE

- .1 Perform Work of this Section by single architectural wood casework fabricator with minimum 5 years of current architectural casework production experience and having completed minimum one project in the past 5 years with value within 20% of the cost of the work of this Section.
- .2 Independent inspection/testing agency may be engaged by Owner for purpose of inspecting and/or testing Work of this Section.
 - .1 Cost of inspection and testing services will be borne by Owner.
- .3 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 00 10 - General Requirements.
 - .2 Shop prepare one base cabinet unit, wall cabinet, countertop, shelving unit, complete with hardware and shop applied finishes, and install where directed by Consultant.
 - .3 Allow 24 hours for inspection of mock-up by Consultant before proceeding with Work.
 - .4 When accepted, mock-up will demonstrate minimum standard for Work.
 - .5 Do not proceed with work before receipt of written acceptance of mock-up by Consultant.
 - .6 Accepted mock-up may remain as part of finished work.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Deliver wood casework only when area of work is enclosed, plaster and concrete work is dry, and area is broom clean and site environmental conditions are acceptable for installation.
- .3 Protect millwork against dampness and damage during and after delivery.
- .4 Store millwork in ventilated areas, protected from extreme changes of temperature and humidity, and within range recommended by AWMAC AWS for location of project.
- .5 Store materials indoors in dry location in clean, dry, well-ventilated area.
- .6 Protect architectural woodwork and hardware from nicks, scratches, and blemishes.
- .7 Replace defective or damaged materials with new.
- .8 Waste Management: for packaging and materials, in accordance with Section 01 00 10 - General Requirements.

PART 2 - PRODUCTS

2.1 QUALITY GRADE

- .1 Provide all materials and perform all fabrication in accordance with AWMAC AWS Custom Grade and as follows, except where specified otherwise:
 - .1 Economy Grade: mechanical rooms and utility areas, storage areas, janitor's closets.
- .2 In case of conflict between Contract Documents and AWMAC AWS grade requirements, Contract Documents govern.

2.2 LUMBER

- .1 Softwood and Hardwood Lumber: Sound lumber to specified AWMAC AWS quality grade requirements, kiln-dried to moisture content recommended by AWMAC AWS for location of the Work.
- .2 Machine stress-rated lumber is acceptable for all purposes.
- .3 Face framing, pulls, trims, molding, edge-banding, stiles and rails: in profiles indicated.

2.3 PANEL MATERIALS

- .1 Interior mat-formed wood particleboard: to ANSI/NPA A208.1, industrial grade M-2 or M-3, medium density (640-800 kg/m³), thickness 19 mm unless indicated otherwise.
 - .1 Use moisture resistant grade 2-M-2 or 2-M-3 for countertops and splash-backs to receive plumbing fixtures.
- .2 MDF (medium density fibreboard) core: to ANSI A208.2, density 769 kg/m³, commercial Grade, 19 mm thick unless indicated otherwise.
 - .1 Use moisture resistant MR grade for countertops and splash-backs to receive plumbing fixtures.
- .3 Douglas fir plywood (DFP): to CSA O121, standard construction.
- .4 Hardwood plywood: to CHPA grading rules, ANSI/HPVA HP-1.
- .5 Canadian softwood plywood (CSP): to CSA O151, standard construction.
- .6 Poplar plywood (PP): to CSA O153, standard construction.
- .7 Hardboard: To CAN/CGSB-11.3.

2.4 LAMINATED PLASTIC MATERIALS

- .1 Laminated plastic for flatwork: to **NEMA LD3**
 - .1 High pressure decorative laminated (HPDL) plastic.
 - .1 Type: GP (general purpose).
 - .2 Horizontal Surfaces: to suit application, 1.2 mm thick.
 - .3 Vertical Surfaces: to suit application, 0.71 mm thick.
 - .4 Colour: integral colour throughout.

- .5 Pattern: solid, woodgrain.
- .6 Finish: satin, textured.
- .2 Laminated plastic for backing sheet:
 - .1 Type: backer.
 - .2 Thickness: not less than 0.5 mm thick or same thickness as face laminate.
 - .3 Colour: same colour as face laminate.
- .3 Laminated plastic liner sheet: CLS grade, 1 mm thick, almond colour.
- .5 Edge finishing for doors, drawer fronts, shelves and false fronts:
 - .1 HPDL to match face.
- .6 Laminated plastic adhesive:
 - .1 Adhesive: laminate manufacturer's recommended type.

2.5 CASEWORK FABRICATION

- .1 Fabricate casework of specified core and surface finish materials to specified AWMAC AWS quality grade
 - .1 Construction type: frameless.
 - .2 Door-cabinet interface: flush overlay.
- .2 Set nails and countersink screws apply stained wood filler to indentations, sand smooth and leave ready to receive finish.
- .3 Shop install cabinet hardware for doors, shelves and drawers. Recess shelf standards unless noted otherwise.
- .4 Shelving to cabinetwork to be adjustable unless otherwise noted.
- .5 Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.
- .6 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.
- .7 Obtain governing dimensions before fabricating items which are to accommodate or abut appliances, equipment and other materials.

2.6 LAMINATED PLASTIC CASEWORK FABRICATION

- .1 Do laminated plastic fabrication in compliance with NEMA LD3, Annex A and specified AWMAC AWS quality grade.
- .2 Ensure adjacent parts of continuous laminate work match in colour and pattern.
- .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 3000 mm. Keep joints 600 mm from sink cutouts.
- .4 Form shaped profiles and bends as indicated, using post-forming grade laminate to laminate manufacturer's instructions.
- .5 Use straight self-edging laminate strip for flatwork to cover exposed edge of core material. Chamfer exposed edges uniformly at approximately 20 degrees. Do not mitre laminate edges.

- .6 Apply laminate backing sheet to reverse side of core of plastic laminate work.
- .7 Apply laminated plastic liner sheet to interior of cabinetry or where indicated.
- .8 Drawer Construction:
 - .1 Sides:
 - .1 Custom grade: LPDL (melamine) or HPDL on MDF, thickness 16 mm.
 - .2 Bottoms: MDF with melamine surfaces, thickness 6 mm.
 - .3 Joinery: Meeting requirements of AWMAC for Grade specified.
 - .1 Sides, front and back: Dowel screwed.
 - .4 Drawer bottoms fully housed into sides and sub front and mechanically fastened to back or plowed into back.

2.7 SHOP APPLIED FINISH COATINGS

- .1 Apply finish system component materials in accordance with manufacturer's instructions.

2.8 CABINET HARDWARE

- .1 Cabinet hardware: to AWMAC AWS quality grade specified and to ANSI/BHMA A156.9, designated by letter B and numeral identifiers as listed below:
- .2 Finish:
 - .1 Exposed hardware: Manufacturer's standard finish.
 - .2 Semi-exposed hardware: Manufacturer's standard finish.
- .3 Casework door hinges: soft close, full overlay hinge.
- .4 Catches and Latches: push/touch or secret panel latch.
- .5 Shelf rests and standards: shelf rest installed in holes drilled, type B04013.
- .6 Drawer slides:
 - .1 Slide type: bottom edge mounted drawer slides.
 - .2 Extension and capacity: full extension meeting requirements of AWMAC AWS for type and size of drawer.
 - .3 File drawer slides: full extension.

2.9 CABINET LOCKS

- .1 Provide locks at all cabinet doors and drawers.
- .2 Cabinet locks: to ANSI/BHMA A156.11.

2.10 ACCESSORIES

- .1 Wood screws: stainless steel, type and size to suit application.
- .2 Nails and staples: to CSA B111 and ASTM F 1667.
- .3 Splines: wood.

- .4 Sealant: in accordance with Section 07 92 00 - Joint Sealants.

2.11 LAMINATED PLASTIC COUNTERTOPS

- .1 Laminated plastic for flatwork: to **NEMA LD3**
 - .1 Type: general purpose.
 - .2 Size: 1.2 mm thick.
 - .3 Colour: integral colour throughout.
 - .4 Pattern: solid, woodgrain.
 - .5 Finish: satin, textured.
- .2 Core material: particleboard or MDF.
 - .1 Countertops to receive plumbing fixtures: Water resistant MDF.
- .3 Back splashes: cove height as indicated.
- .4 Front edges: no drip bullnose edge, or as indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for architectural woodwork installation in accordance with manufacturer's instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

- .1 Install architectural wood casework in accordance with AWMAC AWS grade for respective items.
- .2 In case of conflict between Contract Documents and AWMAC AWS grade requirements, Contract Documents govern.
- .3 Install prefinished millwork at locations shown on drawings.
 - .1 Position accurately, level, plumb straight.
- .4 Fasten and anchor millwork securely.
 - .1 Supply and install heavy duty fixture attachments for wall mounted cabinets.
- .5 Countersink mechanical fasteners at exposed and semi-exposed surfaces, excluding installation attachment screws and screws securing cabinets end to end.
- .6 Use draw bolts in countertop joints.
- .7 Scribe and cut as required to fit abutting walls and to fit properly into recesses and to accommodate piping, columns, fixtures, outlets or other projecting, intersecting or penetrating

objects.

- .8 At junction of plastic laminate counter back splash and adjacent wall finish, apply small bead of sealant in accordance with Section 07 92 00 - Joint Sealants.
- .9 Apply moisture barrier between wood framing members and masonry or cementitious construction.
- .10 Fit hardware accurately and securely in accordance with manufacturer's written instructions.
- .11 Make cutouts for inset equipment and fixtures using templates provided.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with.
 - .1 Clean millwork and cabinet work inside cupboards and drawers and outside surfaces.
 - .2 Remove excess glue, pencil and ink marks from surfaces.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements.

3.4 PROTECTION

- .1 Protect millwork and cabinet work from damage until final inspection.
- .2 Protect installed products and components from damage during construction.
- .3 Repair damage to adjacent materials caused by architectural woodwork installation.
- .4 Leave work to be site finished ready for finishing by Section 09 91 23.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements.

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM C 553-13, Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .2 ASTM C 1320-10, Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction.
- .2 CSA Group (CSA)
 - .1 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
 - .2 CSA B149 PACKAGE-10, Consists of B149.1, Natural Gas and Propane Installation Code and B149.2, Propane Storage and Handling Code.
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S604-2012, Standard for Factory-Built Type A Chimneys.
 - .2 CAN/ULC-S702-2012, Standard for Mineral Fibre Insulation for Buildings.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for blanket insulation and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates:
 - .1 Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .4 Test Reports:
 - .1 Submit certified test reports showing compliance with specified performance characteristics and physical properties.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect specified materials 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.
- .5 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements.

PART 2 - PRODUCTS

2.1 INSULATION

- .1 Batt and blanket mineral fibre: to ASTM C 553 and CAN/ULC-S702.
 - .1 Type: 1.
 - .2 Thickness: as indicated.

2.2 ACCESSORIES

- .1 Insulation clips:
 - .1 Impale type, perforated 50 x 50 mm cold rolled carbon steel 0.8 mm thick, adhesive back, spindle of 2.5 mm diameter annealed steel, length to suit insulation, 25 mm diameter washers of self-locking type.
- .2 Nails: galvanized steel, length to suit insulation plus 25 mm, to CSA B111.
- .3 Staples: 12 mm minimum leg.
- .4 Tape: as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for blanket insulation application in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSULATION INSTALLATION

- .1 Install insulation to maintain continuity of thermal protection to building elements and spaces and to ASTM C 1320.
- .2 Install insulation with factory applied vapour barrier facing warm side of building spaces and vapour permeable membrane facing cold side. Lap ends and side flanges of membrane over framing members. Retain in position with staples, insulation clips, or wire ties installed as recommended by manufacturer. Tape seal butt ends and lapped side flanges. Do not tear or cut vapour barrier.

- .3 Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.
- .4 Do not compress insulation to fit into spaces.
- .5 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN/ULC-S604 Type A chimneys and CSA B149.1 and CSA B149.2 Type B and L vents.
- .6 Do not enclose insulation until it has been inspected and approved by Consultant.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements.
 - .1 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 01 00 10 - General Requirements.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part-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 CAN/ULC S705.1, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Material Specification.
- .3 CAN/ULC S705.2, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Installers Responsibilities Specification.
- .4 CAN/ULC S770, Standard Test Method for Determination of Long-term Thermal Resistance of Closed-Cell Thermal Insulating Foams.

1.3 SUBMITTALS

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 00 10 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 10 10 indicating:
 - .1 Elevations, sections, materials, details of joint conditions, including door, window, entrance framing, flashings, and roof parapet connection.
- .3 Certificates:
 - .1 Submit the following certificates in accordance with Section 01 10 10:
 - .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 logbook 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.

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: 50C to 400C.
 - .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.

Part-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 containing no fluorochemicals and conforming to the following minimum requirements:
 - .1 Aged RSI factor: 0.97 per 25 mm to CAN/ULC S770.
 - .2 Closed cells (ASTM D2856): 92%.
 - .3 Compressive strength (ASTM D1621): 186 kPa (27.0 psi).
 - .4 Water absorption (ASTM D2842): 1.2% by volume.
 - .5 Water vapour permeance (ASTM E96): 50mm sample 42 ng/Pa·s·m² (0.70 perms).
 - .6 Flame spread: <500.
 - .7 Smoke developed: <500.
 - .8 Blowing Agent: Product to utilize Zero ODS (Ozone Depleting Substance) blowing agent.
 - .9 Recycled Content: >5% recycled content by mass of finished product.
 - .10 Sprayed urethane foam: 'Walltite Eco v.2' by BASF or 'Heatlok Soya' by Demilec Inc.
- .3 Primers: As recommended by sprayed foam insulation manufacturer.
- .4 Transition strip membrane:
 - .1 Membrane: 1.0 mm thick, single-ply, self-adhering, self-sealing, rubberised asphalt, bonded to a cross-laminated high density polyethylene film. 'Sopraseal Stick 1100' by Soprema, 'Exo-Air 110' by Tremco, or 'Air-Shield' by W. R. Meadows.

- .2 Primer: 'Elastocol Stick H20' by Soprema, 'ExoAir WB Primer' by Tremco, or 'Mel-Prime Water Base' by W.R. Meadows.
- .3 Mastic: 'Sopramastic' by Soprema, 'Acoustical Sealant' by Tremco, or 'Sealtight Pointing Mastic' by W.R. Meadows.
- .4 Fastening bar: Continuous 25 mm wide x 3 mm thick aluminum bar, predrilled for mechanical attachment.
- .5 Fasteners: As specified herein or manufacturer's recommended fastener for attaching to Substrate.
- .5 Sheet metal closures:
 - .1 Sheet metal: 0.711 mm thick, ASTM A653/A653M Grade A, Z275 Commercial Quality zinc coating.
 - .2 Joint sealing tape: 100% solid, cross linked butyl, preformed sealant tape; 'Tremco 440 Tape' by Tremco Ltd. or approved alternative.
 - .3 Sealant: 'One-part, non-sag; 'TRS 600' by Tremco Ltd., 'NovaLink' by ChemLink, or approved alternative.

Part-3 EXECUTION

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

3.2 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 TRANSITION STRIPS

- .1 Install transition strips at all joints, expansions, cracks and other locations of movement to ensure continuity of air/vapour retarder.
- .2 Mastic and Primer:
 - .1 Fill substrate voids, gaps, depressions, cracks, and joints with mastic until

- continuous, smooth, substrate for transition strip membrane is achieved.
- .2 Prime substrate surfaces to receive membrane 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 transition strip membrane within 4 hours.
- .3 Transition strip membrane installation:
 - .1 Install mastic where required to ensure integrity of transition strip membrane installation at protrusions and other complex details.
 - .2 Install transition strip membrane in accordance with manufacturer's instructions in locations indicated.
 - .3 Lap membrane ends and edges 50 mm minimum. Roll membrane and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.
 - .4 Extend transition strip membrane as required to connect to other components of Work comprising transition strip system.
 - .5 Cut and fit membrane as required for passage of protrusions, ensuring continuous adherence to substrate.
 - .6 At end of days' Work, trowel mastic water cut-off along uppermost edge of incomplete membrane assembly, to prevent loss of adhesion and damage to transition membrane.
- .4 Fastening bars: Supply and install continuous mechanical fastening bar to clamp transition strip membrane both sides of unfilled gaps, cracks, and joints.

3.4 SHEET METAL CLOSURES

- .1 Provide sheet metal closures at all joints over 25 mm. Ensure surfaces receiving sealant or tape are dry, firm, straight, and free of loose material, projections, ice, frost, grease or oil, or other detrimental material.
- .2 Secure sheet metal closures with self-tapping screws at 150 mm O.C. along edges of panels and 450 mm O.C. at intermediate fixings.
- .3 At overlapping sheet metal edges, apply a continuous strip of tape; also gun-apply a continuous 6 mm bead of sealant along sheet metal edges. Liberally butter all screw fastenings penetrating the metal sheet closures or use self-sealing (EPDM) washers at each screw fastener.

3.5 SPRAY INSULATION

- .1 Install insulation in accordance with manufacturer's written instructions.
- .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 m².
- .3 Insulation thickness greater than 50 mm shall be completed in a minimum of 2 steps.

- .4 Insulation to be continuous, level, plumb and uniform thickness throughout. Insulation shall be free of voids and imbedded foreign materials.
- .5 Trim all excess insulation in accordance with manufacturer's instructions.

3.6 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

Part-1 General

1.1 SECTION INCLUDES

- .1 Labour, Products, equipment and services necessary for vapour retarders 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.

1.3 SUBMITTALS

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 10 10 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.

1.4 QUALITY ASSURANCE

- .1 Mock-up:
 - .1 Construct one 10 m2 mock-up of each type vapour retarder in location acceptable to Consultant indicating as a minimum one lap joint, one inside corner, one window interface, and one electrical box.
 - .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.

Part-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 Polyethylene film: to CAN/CGSB-51.34, 0.10 mm thick.
- .3 Membrane vapour retarder: 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.
- .4 Primer:
 - .1 'Cav-Grip Primer' by Carlisle Coatings & Waterproofing.
 - .2 'Aquatac' by Henry Company Canada Inc.
 - .3 'Elastocol Stick H20' by Soprema.
 - .4 'ExoAir WB Primer' by Tremco
 - .5 'Mel-Prime Water Base' by W.R. Meadows.
- .5 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.
- .6 Fastening bar: Continuous 25 mm wide x 3 mm thick aluminum bar, predrilled for mechanical attachment.
- .7 Fasteners: As specified herein or manufacturer's recommended fastener for attaching to Substrate.
- .8 Vapour retarder (under slab): ASTM E1745, Class A, 0.38 mm (15 mil) thick; '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 vapour retarder manufacturer.
 - .2 Pipe and conduit boots: Construct pipe and conduit boots from vapour retarder material and pressure sensitive tape as recommended by manufacturer.
- .9 Vapour retarder (over slab): High performance, rapid drying, water-based, in according with manufacturer's recommendations.
- .10 Joint sealing tape: Air 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.
- .11 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.

Part-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 vapour retarder are clean, dry, sound, smooth, and continuous.
- .3 Coordinate installation of vapour retarders with work of other Sections to achieve a vapour tight building envelope.

3.2 SHEET VAPOUR RETARDER INSTALLATION

- .1 Ensure services are installed and inspected prior to installation of retarder.
- .2 Install sheet vapour retarder under the floor slab prior to installation of floor slab, to form a continuous vapour retarder in accordance with ASTM E1643 and manufacturer's written instructions.
- .3 Lap 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 with sealing tape before work is concealed.
- .8 Ensure continuity of vapour retarder is maintained at junctures with other materials.
- .9 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 Install fasteners through lapped sheets at sealant bead into substrate.
 - .4 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.
- .10 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 Install fasteners through lapped sheets at sealant bead into substrate.
 - .5 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring

in sheet over sealant.

3.3 MASTIC AND PRIMER

- .1 Fill substrate voids, gaps, depressions, cracks, and joints with mastic until continuous, smooth, substrate for vapour retarder is achieved.
- .2 Prime substrate surfaces to receive vapour retarder 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 vapour retarder within 4 hours.

3.4 MEMBRANE VAPOUR RETARDER INSTALLATION

- .1 Install mastic where required to ensure integrity of vapour retarder installation at protrusions and other complex details.
- .2 Install vapour retarder in accordance with manufacturer's instructions in locations indicated.
- .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 Extend vapour retarder as required to connect to other components of Work comprising vapour retarder system.
- .5 Cut and fit vapour retarder as required for passage of protrusions, ensuring continuous adherence to substrate.
- .6 At end of days' Work, trowel mastic water cut-off along uppermost edge of incomplete vapour retarder assembly, to prevent loss of adhesion and damage vapour retarder.

3.5 FASTENING BARS

- .1 Supply and install continuous mechanical fastening bar to clamp vapour retarder both sides of unfilled gaps, cracks, and joints.

3.6 FIELD QUALITY CONTROL

- .1 Inspect vapour retarder continuity immediately prior to installation of subsequent construction. Repair punctures, rips and tears to ensure continuity of vapour retarder.
- .2 Where punctures and tears are extensive, replace entire damaged section.
- .3 Do not cover or permit to be covered any portion of vapour retarder until it has been inspected by Consultant.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements.

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM A 167-99(2004), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - .2 ASTM A 240/A 240M-05a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .3 ASTM A 480/A 480M-05, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - .4 ASTM D 523-89(R1999), Standard Test Method for Specular Gloss.
 - .5 ASTM D 822-01, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 19-GP-14M-76(R1984), Sealing Compound, One Component, Butyl-Polyisobutylene Polymer Base, Solvent Curing.
- .3 Green Seal Environmental Standards
 - .1 Standard GC-03-93, Anti-Corrosive Paints.
 - .2 Standard GS-11-97, Architectural Paints.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .5 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-05, Adhesives and Sealants Applications.

1.3 DESIGN REQUIREMENTS

- .1 Design metal cladding to allow for thermal movement of component materials caused by variation in ambient temperature range of 80 degrees C without causing buckling, failure of joint seals, undue stress on fasteners or other detrimental effects.
- .2 Maximum deviation from vertical and horizontal alignment of erected panels: 1 to 1000.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature for cladding system materials, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies WHMIS SDS - Safety Data Sheets.
- .3 Shop Drawings:

- .1 Shop drawings: Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .2 Indicate dimensions and thickness of panels, fastening and anchoring methods, detail and location of joints and gaskets, thermal movement provision, wall openings, head, jamb and sill details, materials and finish, compliance with design criteria and requirements of related work.
- .4 Samples:
 - .1 Submit duplicate 300 x 300 mm samples of wall system, representative of materials, finishes and colours.
- .5 Quality assurance submittals: submit following in accordance with Section 01 00 10 - General Requirements.
 - .1 Certificates: submit certificates signed by manufacturer certifying that composite wall panels comply with specified performance characteristics and physical properties.
 - .2 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.
 - .3 Manufacturer's Site Reports: submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - SITE QUALITY CONTROL.

1.5 QUALIFICATIONS

- .1 Manufacturer: company specializing in producing composite wall panels with 5 years documented experience with sufficient capacity to produce and deliver required units without causing delay in work.
- .2 Installer: person specializing in composite wall panel installations with 5 years documented experience and approved by manufacturer.
- .3 Mock-ups: construct mock-ups in accordance with Section 01 00 10 - General Requirements and to requirements supplemented as follows:
 - .1 Provide mock-up for evaluation of surface finishes and workmanship.
 - .2 Provide initial production units for job-site assembly with other materials for review and approval.
 - .3 Coordinate type and location of mock-ups with project requirements.
 - .4 Accepted units will be used as standard for acceptance of production units.
 - .5 Remove and replace units which are not accepted.
 - .6 Do not proceed with remaining work until workmanship, colour, and finish are reviewed, approved, and accepted by Consultant.
 - .7 Refinish mock-up area as required to produce acceptable work.
 - .8 When accepted, mock-up will demonstrate minimum standard of quality required for this work.
- .4 Preinstallation Meetings: convene preinstallation meeting one week before to beginning work of this Section and on-site installation, with contractor's representative and Consultant in accordance to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Coordination with other building subtrades.

- .4 Review manufacturer's installation instructions and warranty requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and protect material in accordance with panel manufacturer's recommendations.
- .2 Do not expose panels with strippable film to direct sunlight or extreme heat.
- .3 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

1.7 WARRANTY

- .1 Manufacturer's Warranty: Submit manufacturer's written two (2) year limited warranty providing materials to be free from defects in material and workmanship from the date of production excluding coil coatings and paint finishes that are covered under a separate warranty.
- .2 Paint Finish Warranty: Submit Manufacturer's limited warranty on exterior paint finish for adhesion to metal substrate and on exterior paint finish for chalk, fade and cracking.
- .3 Installer's Warranty: Installation contractor to issue separate warranty against defects in installed materials and workmanship, beginning from date of substantial completion of installation.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 INSULATED METAL WALL PANELS:
 - .1 Exterior metal substrate: G90 galvanized coated steel to ASTM A653 or AZ50 aluminum-zinc (Galvalume) alloy coated steel, to ASTM A792, minimum grade 33, pre-painted by coil-coating process to ASTM A755.
 - .1 Finish: Fluoropolymer (PVDF) Two-Coat System, 1.0 mil dry film thickness.
 - .2 Color: As Selected by Architect from manufacturer's standard colors.
 - .3 Texture: Embossed with lightly planked ribs.
 - .4 Facing Thickness: 22 ga.
 - .2 Interior metal substrate: G90 galvanized coated steel to ASTM A653 or AZ50 aluminum-zinc (Galvalume) alloy coated steel, to ASTM A792, minimum grade 33, pre-painted by the coil-coating process to ASTM A755.
 - .1 Finish: Fluoropolymer (PVDF) Two-Coat System, 1.0 mil dry film thickness.
 - .2 Texture: Embossed with lightly planked ribs.
 - .3 Facing Thickness: 22 ga.
 - .4 Color: Imperial White.
 - .3 Core: Polyisocyanurate foam core meet or exceed following physical properties:
 - .1 Compressive Strength (ASTM D1621): 14 PSI
 - .2 Density, in-place (ASTM D1622): 2.00 - 2.50 PCF
 - .3 Shear Strength (ASTM C273): 14 PSI

- .4 Tensile Adhesion (ASTM D1623): 8.25 PSI
- .5 Closed Cell Content (ASTM D6226): 91%
- .6 Dimensional Stability (ASTM D2126):
 - .1 14 day aged < 1% change at -20 degree F,
 - .2 < 1.5% change at 158 degree F dry heat,
 - .3 < 4.5% change at 158 degree F humid heat.
- .4 Acceptable Product: All Weather Insulated Panels, DM40.
 - .1 Manufactured by: Vicwest Building Products.
- .2 Panel Clips: Galvanized one-piece wall clips use in concealed panel joint.
- .3 Panel Fasteners: Self-drilling or self-tapping screws and other acceptable fasteners recommended by panel manufacturer. Exposed corrosion-resistant fasteners with heads matching color of metal panels by factor-applied coating, with weather tight sealing washers.
- .5 Concealed sealants: one-component, butyl-polyisobutylene polymer base, solvent curing to CGSB 19-GP-14M.
- .7 Exposed sealants: one-component, silicone base, solvent curing, colour to match panel.

2.2 FABRICATION

- .1 Composition: two sheets of \steel sandwiching core of extruded thermoplastic formed in continuous process with no glues or adhesives.
- .2 Factory fabricated.
- .3 Tolerances:
 - .1 Panel bow: maximum 0.8% of panel dimension in width and length.
 - .2 Panel dimensions: where final dimensions cannot be established by site measurement before completion of panel manufacturing, make allowance for site adjustments as recommended by manufacturer.
 - .3 Panel lines, breaks and angles: sharp, true and surfaces free from warp or buckle.

PART 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 EXAMINATION

- .1 Before installation examine alignment of substrate and notify Consultant in writing if substrate does not comply with requirements of panel installer.

3.3 INSTALLATION

- .1 Install composite panels in accordance with manufacturer's written instructions and shop drawings.

- .1 Allow for thermal movement.
- .2 Maintain following installation tolerances:
 - .1 Maximum variation from plane or location shown on shop drawings: 10 mm/10 m of length and up to 20 mm/100 m.
 - .2 Maximum deviation for vertical member: 3 mm in an 8.5 m run.
 - .3 Maximum deviation for a horizontal member: 3 mm in an 8.5 m run
 - .4 Maximum offset from true alignment between two adjacent members abutting end to end, in line: 0.75 mm.
- .3 Remove strippable coating from panels as they are erected.

3.4 SITE QUALITY CONTROL

- .1 Manufacturer's Site Services:
 - .1 Provide manufacturer's site services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 00 10 - General Requirements.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Leave work areas clean, free from grease, finger marks and stains.

END OF SECTION

Part-1 General

1.1 SUMMARY

- .1 This Section includes requirements for supply and installation of an elastomeric membrane roofing system including, but not limited to, the following:
 - .1 Adhered membrane roofing system.
 - .2 Membrane installation accessories, anchors, adhesives and sealants.
 - .3 High density cover board (between membrane and insulation).
 - .4 Roof insulation.
 - .5 Vapour retarder.
 - .6 Gypsum auxiliary levelling board on steel roof deck.

1.2 RELATED SECTIONS

- .2 Section 05 31 00 – Metal Decking.
- .3 Section 06 10 00 – Rough Carpentry.
- .4 Section 07 62 00 – Sheet Metal Flashing and Trim.
- .5 Section 07 72 33 – Roof Hatches.
- .6 Section 07 92 00 – Joint Sealants
- .7 Section 07 95 00 – Expansion Control.
- .8 Section 20 05 23 – Plumbing Specialties.

1.3 REFERENCES

- .1 Canadian Roofing Contractors' Association (CRCA):
 - .1 Roofing Specification Manual.
- .2 National Roofing Contractors' Association (NRCA):
 - .1 Quality Control Recommendations for EPDM Roofing.
- .3 American National Standards Institute (ANSI):
 - .1 ANSI/SPRI RP-4-2022 Wind Design Standard For Ballasted Single-Ply Roofing Systems.
- .4 American Society for Testing of Materials (ASTM International):
 - .1 ASTM C1002-22, Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - .2 ASTM C1396/C1396M-17, Standard Specification for Gypsum Board.
 - .3 ASTM D448-12(2022), Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
 - .4 ASTM D4263-83(1999) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
 - .5 ASTM D4637-24, Standard Specification for EPDM Sheet Used In Single-Ply Roof Membrane.

- .6 ASTM D6383/D6383M-99(2021) Standard Practice for Time-to-Failure (Creep-Rupture) of Adhesive Joints Fabricated from EPDM Roof Membrane Material.
- .5 Canadian Standards Association (CSA Group):
 - .1 CAN/CSA A123.21-04, Standard Test Method for the Dynamic Wind Uplift Resistance of Mechanically Attached Membrane-Roofing Systems.
 - .2 CSA B111-1974 (R2003), Wires, Nails, Spikes and Staples.
- .6 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC S107-10, Methods of Fire Tests of Roof Coverings.
 - .2 CAN/ULC S701.1, Standard for Thermal Insulation, Polystyrene, Boards.
 - .3 CAN/ULC S704.1, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced.
 - .4 CAN/ULC S706-09 Standard for Wood Fibre Thermal Insulation for Buildings.

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Construction Meeting: Arrange a pre-construction meeting attended by roofing manufacturer's representative, roofing contractor's representative, roofing inspector, the Contractor or Construction Manager and Consultant to review installation conditions particular to this project and as follows:
 - .1 Review materials specified in this Section and identify any coordination or installation issues affecting construction.
 - .2 Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 - .3 Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - .4 Examine deck substrate conditions and finishes for compliance with manufacturer's requirements including flatness and fastening.
 - .5 Review structural loading limitations of roof deck during and after roofing.
 - .6 Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 - .7 Review governing regulations and requirements for insurance and certificates if applicable.
 - .8 Review temporary protection requirements for roofing system during and after installation.
 - .9 Review roof observation and repair procedures after roofing installation.
 - .10 Roofing inspector will complete minutes and prepare report for this meeting.
 - .11 Coordination: Coordinate compatibility of materials: provide materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and site experience; roofing materials to be compatible with air and vapour retarder specified under Section 07 26 00 – Vapour Retarders.

1.5 SUBMITTALS

- .1 Provide required information in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Action Submittals: Provide the following submittals before starting any Work of this Section:
 - .1 Product Data: Submit electronic copies in .PDF format of manufacturer's technical data sheets describing materials' physical properties, explanations about product installation including installation techniques, restrictions, limitations and other manufacturer recommendations.
 - .2 Shop Drawings: Submit membrane manufacturer's standard details being used for this project, indicate changes made to make details project specific. Include sloped insulation manufacturer's proposed roofing diagrams and layouts for review.
- .3 Informational Submittals: Provide the following submittals before beginning the Work of this Section:
 - .1 Declaration of Material Compatibility: Provide a written declaration to the Consultant that roofing all materials and components are compatible with wall air and vapour retarder membranes.
 - .2 Certificates: Submit installer certificates signed by roofing system manufacturer certifying that installer is approved, authorized, or licensed by manufacturer to install roofing system.
 - .3 Site Quality Control Submittals: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.6 PROJECT CLOSEOUT SUBMISSIONS

- .1 Provide operations and maintenance information in accordance with Section 01 79 00 – Closeout Submittals.

1.7 QUALITY ASSURANCE

- .1 Regulatory Requirements: Perform roofing and sheet metal work in conformance with the roofing manufacturer's written recommendations using materials that meet the requirements of CAN/ULC S107 to obtain a Class A fire resistance rating. Submit proof that roofing materials meet required performance when requested by the Consultant.
- .2 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Manufacturer: Obtain roofing membrane materials through one source from a single manufacturer or using materials from a secondary source that are acceptable to the manufacturer.
 - .2 Installer: Use an installation company that is a member in good standing of the Canadian Roofing Contractors Association (CRCA), using workers who are trained and approved by the roofing membrane manufacturer; maintain a full-time experienced journeyman roofer, and at least one apprentice per crew on the Work always.

1.8 DELIVERY, STORAGE, AND HANDLING

- .3 Delivery and Acceptance Requirements: Deliver roofing materials to site packaged in original containers with seals unbroken and labelled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- .4 Storage and Handling Requirements: Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck and as follows:
 - .1 Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 - .2 Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources; store in a dry location in accordance with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

1.9 SITE CONDITIONS

- .1 Ambient Conditions: Proceed with installation only when existing and forecasted weather conditions permit roofing system installation in accordance with manufacturer's written instructions and warranty requirements.
- .2 Apply roofing only when air and surface temperatures are above 4 degrees Celsius, have been so for at least 48 hours and are not likely to go below 4 degrees Celsius, until Work is completed.
- .3 Proceed with Work when temperatures are below 4 degrees Celsius only with mutual documented agreement between Contractor and Consultant.
- .4 Dispose of rainwater off roof and away from face of building until roof drains or hoppers are installed and connected.
- .5 Environmental Requirements:
 - .1 Install roofing components on dry deck, free of snow and ice, use only dry materials and apply only during weather that will not introduce moisture into roofing system.
 - .2 Apply roofing only when air and surface temperature are in accordance with manufacturer's installation instructions.
- .6 Safety Requirements:
 - .1 Use warning signs and barriers. Maintain in good order until completion of Work.
 - .2 Fire protection: Have minimum 9 kg. dry chemical fire extinguisher fully charged and in operable condition at every location where open flames are used.
- .7 Protection:
 - .1 Protect Work of other Sections from damage while doing this Work. Provide tarpaulins and other coverings, as required, to protect adjacent wall finishes and surfaces.

- .2 Adequate care should be taken by all trades and end users to protect completed membranes from mechanical damage during and after construction.
- .3 Protect membranes from contact with bituminous and other incompatible materials.
- .4 Seal exposed edges of membrane to prevent water infiltration into the system at end of each day's work.
- .5 Protect completed portions of roofs from damage by placing 19 mm plywood on 25 mm extruded polystyrene to serve as runways for movement of materials and other traffic.
- .6 Protect partially completed Work of this Section left exposed longer than eight (8) hours.
- .7 Take every precaution to protect the interior of the building from water damage and will not expose the interior to adverse atmospheric conditions, which may cause such damage.
- .8 Repair or replace damaged areas to satisfaction of Consultant.

1.10 SITE PROTECTION

- .1 During installation of roofing, protect finished work completed, in progress and at other stages of completion from deterioration, defacement, harm and other types of damage that may be caused by construction activities at the Place of Work including but not limited to welding, cutting, torching, grinding, improper material handling and transportation of persons, products and materials.
- .2 The Contractor and the roofing Subcontractor are jointly responsible to supply and install protective boardwalks over roofing materials of sufficient strength and durability to facilitate passage of people, products and to protect finishes from inadvertent damage.
- .3 The Contractor will assume full responsibility for damages and provide labour and materials as required to repair damage. Where damage cannot be repaired, the Contractor will be responsible to remove existing damaged materials and replace with new using only specified products.
- .4 The Contractor, at their sole discretion, may assign costs for repairs or replacement to the responsible Subcontractor.

1.11 WARRANTY

- .1 Manufacturer Warranty: Product manufacturer must issue a written and signed warranty in the Owner's name, certifying product performance properties for a period of 20 years, starting from the date of acceptance, covering wholly and completely the specified warranty period starting from Substantial Performance of the entire Contract.
- .2 Special Warranty: In addition to the manufacturer's warranty, provide a CRCA 2-year Certificate of Assurance.

Part-2 Products**2.1 MANUFACTURERS**

- .1 Acceptable Materials Manufacturers: Subject to compliance with requirements specified in this Section, manufacturers offering products that may be incorporated into the Work include but are not limited to, the following:
 - .1 Carlisle SynTec Incorporated (Sure-Tough).
 - .2 Elevate Roofing.
 - .3 Genflex Roofing Systems.
 - .4 John Manville.

2.2 PERFORMANCE REQUIREMENTS

- .1 Compatibility: Verify that roofing materials are provided by the same manufacturer or are compatible with one another when provided by different manufacturers and as follows:
 - .1 Roofing materials must be compatible with air and vapour retarder specified under Section 07 26 00 – Vapour Retarders.
 - .2 Provide a written declaration to the Consultant that roofing materials and components are compatible with wall air and vapour retarder membranes.
- .2 Provide a membrane roofing system that has been tested successfully, and that resists corner, perimeter and field-of-roof uplift pressure criteria established by the Ontario Building Code, 1/50-year wind pressures for location of installation.

2.3 MATERIALS

- .1 Auxiliary Levelling Surface: Gypsum sheathing having a Type X fire rating and treated gypsum core manufactured in accordance with ASTM C1396, with moisture resistant paper facers compatible with membrane system suitable for normal humidity buildings and as follows:
 - .1 Thickness: 16 mm.
 - .2 Long Edges: Square.
 - .3 Location: Roof substrates over steel decks only, for support of vapour barrier and to provide fire resistance rating to roof assembly.
 - .4 Acceptable Materials:
 - .1 CertainTeed GlasRoc Sheathing Type X.
 - .2 CGC Gyplap Sheathing Firecode Core.
 - .3 Georgia Pacific Toughrock Sheathing Type X.
- .2 High Density Cover Board: Glass mat faced, mould resistant roof sheathing boards having a Type X fire rating and treated gypsum core manufactured in accordance with ASTM C1177, non-asphaltic primed surface, and as follows:
 - .1 Thickness 13 mm as indicated.
 - .2 Long Edges: Square.
 - .3 Location: Below EDPM membrane and above roof insulation.
 - .4 Acceptable Materials:
 - .1 CertainTeed GlasRoc Sheathing Type X.

- .2 CGC Securock Ultra-Light Glass-Mat Roof Board Sheathing Firecode Core.
- .3 Georgia Pacific DensDeck StormX Prime Roof Board Type X.
- .3 Adhesives:
 - .1 Membrane Roofing Materials Adhesive: Manufacturer's recommended cold process materials compatible with specified roofing products.
 - .2 Insulation Adhesive: Manufacturers recommended adhesives specifically formulated for installation of plastic insulation to roofing materials and meeting accepted products status for specified Warranty Certificate.
 - .3 Gypsum Board Adhesive: Manufacturer's recommended adhesives specifically formulated for installation of gypsum board to metal deck.
- .4 Vapour Retarder: Premanufactured modified bituminous, self-adhering vapour retarder, designed specifically for installation to dry steel decks having a width of 1 140 mm with a non-slip surface and UV resistant opaque surface:
 - .1 Acceptable Materials:
 - .1 Bakor Vapor-Bloc SA.
 - .2 IKO Modified Vapour Protector.
 - .3 Soprema Sopravap'R.

- .5 Vapour Retarder Continuity Strip: SBS membrane with non-woven polyester reinforcement, glass grid and elastomeric bitumen having a sanded upper surface and self-adhesive underside compatible with wall and roof air / vapour retarder membranes and as recommended by acceptable vapour retarder membrane manufacturers listed above.
 - .1 Wood Roof Materials: As indicated in Section 06 10 00 – Rough Carpentry.
- .6 Insulation:
 - .1 Primary Flat and Sloped Insulation: Polyisocyanurate foam rigid board roof insulation consisting of largest panels practical, having square edges, minimum RSI 1.04 / 25 mm, total thickness as indicated on Drawings, sloped to a minimum 2 percent perpendicular from edge of roof to a minimum thickness of 12 mm; conforming to ULC S704, Type 3, Class 2, to a tolerance not exceeding 3 mm from nominal size in any dimension:
 - .1 Acceptable Materials:
 - .1 Atlas AC Foam III.
 - .2 Carlisle SecurShield Tapered.
 - .3 ELEVATE ISOGARD™.
 - .4 Johns Manville, E'NRG'Y 3.
 - .5 Soprema SOPRA-ISO.

.7 Fasteners:

- .1 Insulation Fasteners to Decking: Screws and stress plates, galvanized steel, minimum 50 mm diameter spaced one per 0.25 m², penetrating a minimum of 38 mm into top of flutes for corrosion and wind lift factors.

- .2 Roofing Nails: Spiral nails with steel round top cap 25 mm in diameter and 3 mm diameter shank, length to penetrate solid wood supports by at least 38 mm and plywood substrates by at least 19 mm.
- .8 Elastomeric Membrane: Flexible ethylene propylene diene monomer (EPDM) sheet membrane meeting requirements of ASTM D4637 or CAN/CGSB 37-GP-52M and as follows:
 - .1 Type I, fabric internally reinforced.
 - .2 Thickness: Nominal 1.5 mm (60 mils).
 - .3 Exposed Face Colour: White-on-black.

2.4 ACCESSORIES

- .1 Auxiliary Materials: As recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
 - .1 Sheet Metal Flashing: Refer to Section 07 62 00 – Sheet Metal Flashing and Trim.
- .2 Membrane Flashing: Nominal 1.5 mm (60 Mil) thick EPDM partially cured according to application and manufacturer's standard details.
- .3 Preformed Cant Strips and Tapered Edge Strips: Laminated, high density fibre reinforced board with perlite insulation, asphalt impregnated, approximately 100 x 100 mm x 38 mm thick, and as follows:
 - .1 Basis-of-Design Materials:
 - .1 Johns Manville, FesCant Plus Cant Strip and Tapered Fesco Edge Strip.
- .4 Bonding Adhesive: Manufacturer's standard bonding adhesive.
- .5 Seaming Material: Manufacturer's standard synthetic rubber polymer primer and minimum 75 mm wide butyl splice tape with release film.
- .6 Water Cut-off Mastic: Manufacturer's standard butyl mastic sealant.
- .7 Metal Termination Bars: Manufacturer's standard predrilled stainless steel or aluminum bars, approximately 25 mm x 3 mm with manufacturer recommend anchors.
- .8 Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories required for a complete roofing system in accordance with manufacturer's requirements for specified roof system.
- .9 Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric mat, water permeable and resistant to ultraviolet degradation, type and weight as recommended by roofing system manufacturer for application.
- .10 Concrete Pavers: Where indicated, high density hydraulic pressed pavers, nominal 600 mm x 600 mm weight not exceeding 45 kg per unit, colour selected by Consultant from standard range.

- .11 Premanufactured Pipe Supports: Premanufactured pipe supports fabricated from 100 percent recycled rubber, with 2.7 mm thickness galvanized steel frame, 150 mm wide x 100 mm tall x length to suit installation; including fasteners, bridge components, and angled supports as required for a complete installation and having the following accessories:
 - .1 Pipe and Conduit Support: Galvanized pipe clamp sized to suit gas pipe in accordance with manufacturer's instructions.
 - .2 Multi-Pipe and Conduit Support: Galvanized pipe support system size and number to suit pipes being supported in accordance with manufacturer's instructions.
 - .3 Extendable Height Support: Galvanized steel pipe extensions to suit installation in accordance with manufacturer's instructions.
- .12 Flexible Walkways: Factory formed, nonporous, heavy duty, solid rubber, slip resisting, surface textured walkway pads or rolls, approximately 5 mm thick, and acceptable to membrane roofing system manufacturer.
- .13 Roof Drains: As specified in Section 20 05 23 – Plumbing Specialties.

Part-3 Execution

3.1 EXAMINATION

- .1 Examine substrates, areas, and conditions for compliance with the following requirements and other conditions affecting performance of roofing system:
 - .1 Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
 - .2 Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - .3 Verify that roof drains, curbs, penetration pockets, and similar details including mechanical and electrical items are located a minimum of 900 mm from perimeters.
 - .4 Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 5 Section "Steel Deck."
 - .5 Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- .1 Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- .2 Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof drain plugs when no work is taking place or when rain is forecast.

- .3 Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 INSTALLATION

- .1 Conform to Roofing Specifications as published by Canadian Roofing Contractors Association (CRCA) as a reference.
- .2 Vapour Retarder Levelling Surface: Adhere gypsum board levelling surface into the upper rib surfaces of steel decks.
 - .1 Cut boards so edges rest on centre of upper ribs. Cut straight lines with adequate tools.
 - .2 Cut boards cleanly where slopes change directions; avoid breaking boards to acquire deck form.
 - .3 Place boards perpendicular to deck ribs for continuous support at extremities.
 - .4 Stagger board joints in half lengths, tightly butted.
- .3 Vapour Retarder Installation:
 - .1 Install pre-manufactured membrane vapour retarder in accordance with manufacturer's written instructions.
 - .2 Install vapour retarder membrane onto dry substrate in accordance with CRCA Guidelines for normal humidity conditions. Overlap side laps by 100 mm and end laps by 150 mm with laps staggered a minimum of 305 mm and fully sealed with hot asphalt. Begin work at bottom of slopes.
 - .3 Install roof vapour retarder to meet and overlap air and vapour retarder membrane from adjoining walls to ensure total continuity.
 - .4 Install vapour retarder membrane at insulation perimeters and around each element piercing the insulation to ensure sealed connections with base sheet at up stands.
- .4 Insulation Installation: Apply 2-layers insulation with joints tightly butted, and with upper surface flush across joints, following layout procedures recommended by manufacturer, in accordance with reviewed shop drawings; fill gaps greater than 6 mm wide with insulation, and as follows:
 - .1 Cut insulation to fit neatly to perimeter blocking and around all projections through roof.
 - .2 Apply no more insulation than can be covered with roof membrane on same day.
 - .3 Vertical joints between level boards and sloped modules, and between two rows of insulation board must be staggered.
 - .4 Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards.
 - .5 Install each layer of insulation and adhere to substrate in accordance with adhesive manufacturer's written instructions, and as necessary to resist uplift pressure at corners, perimeter, and field of roof.
- .5 Installation of Insulation Overlay: Install membrane underlayment in accordance with CRCA or manufacturer's written requirements, and as follows:

- .1 Firmly set the insulation overlay boards, long joints continuous and short joints staggered. Boards must be evenly and tightly butted together, with joints offset from primary insulation joints.
- .2 Apply only as many boards as can be covered by roofing membrane in the same day.
- .3 Cut out a 10 mm slope in a 610 mm radius around drains.
- .6 Base Flashing Installation: Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions and as follows:
 - .1 Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.
 - .2 Flash penetrations and site formed inside and outside corners with cured or uncured sheet flashing.
 - .3 Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
 - .4 Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.
- .7 Walkway Installation:
 - .1 Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
 - .2 Service Lines, Walkways and Penetrations: Install premanufactured service line supports and penetrations in accordance with manufacturer's written instructions space blocks at 3 metres maximum centres.

3.4 SITE QUALITY CONTROL

- .1 Inspection and Testing of roofing installation will be undertaken by roof consultant chosen by the Owner.
- .2 Inspection fees will be paid by the Owner in accordance with Section 01 45 00 – Quality Control from the Cash Allowance on behalf of the Owner.
- .3 Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Consultant.
- .4 Notify Consultant or Owner 48 hours in advance of date and time of inspection.
- .5 Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.

3.5 PROTECTING AND CLEANING

- .1 Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Consultant and Owner.

- .2 Correct deficiencies or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Performance and according to warranty requirements.

3.6 CLEANING

- .1 Clean roofing, metal, masonry, and similar items of dirt, cuttings, stains and foreign matter upon completion of the Work.

END OF SECTION

PART-1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Waste Management and Disposal.
- .3 Section 01 74 00 - Cleaning.
- .4 Section 07 92 00 - Joint Sealants

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM A 653/A 653M-15e1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM D 523-14, Standard Test Method for Specular Gloss.
 - .3 ASTM D 1970/D 1970M-15a Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
 - .4 ASTM D 4587-11 Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings.
- .2 Canadian Roofing Contractors Association (CRCA)
 - .1 Roofing Specifications Manual 2012.
- .3 CSA Group (CSA)
 - .1 CSA A123.22-08(2013) Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .5 Sheet Metal and Air Conditioning Contractors Association of North America (SMACNA)
 - .1 Architectural Sheet Metal Manual (2012)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature including product specifications and technical data sheets for sheet metal flashing fasteners and accessory materials. Include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies WHMIS SDS - Safety Data Sheets.
- .3 Shop Drawings:
 - .1 Submit shop drawings only for sheet metal flashing and trim items that differ from those indicated in Contract Documents for all sheet metal fabrications.

- .2 Indicate sheet thickness, flashing dimensions and fastenings. Include anchorage, expansion joints and other provisions for thermal movement.
- .3 Submit manufacturer's catalogue cut sheets for manufactured items.
- .4 Samples:
 - .1 Submit duplicate 50 x 50 mm samples of each type of sheet metal material, finishes and colour.

1.4 PREINSTALLATION MEETING

- .1 Include sheet metal flashing and trim on agenda of preinstallation meetings of affected sections.

1.5 MOCK-UPS

- .1 Include flashings in mock-ups as specified for work of other affected sections.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Handle and store flashing materials to prevent creasing, buckling, scratching, or other damage.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

PART-2 PRODUCTS

2.1 BASE SHEET METAL MATERIALS

- .1 Zinc coated steel sheet: 0.6 mm thickness, commercial quality to ASTM A 653/A 653M, with Z275 designation zinc coating.

2.2 PREFINISHED STEEL SHEET

- .1 Prefinished steel with factory applied primer and polyvinyl chloride heat-cured topcoat.
 - .1 Class F1S.
 - .2 Colour selected by Consultant from manufacturer's standard.
 - .3 Specular gloss: 30 units +/- 5 in accordance with ASTM D 523.
 - .4 Coating thickness: not less than 200 micrometers.
 - .5 Resistance to accelerated weathering for chalk rating of 8, colour fade 5 units or less and erosion rate less than 20% to ASTM D 4587 as follows:
 - .1 Cycle #4 General Metal Coatings.
 - .2 Exposure period: 2000 hours.

2.3 ACCESSORIES

- .1 Isolation coating: alkali resistant bituminous paint.
- .2 Pourable sealer: proprietary two-part polyurethane pourable sealer designed for sealing

-
- penetration pockets.
- .3 Loose laid underlay for metal flashing: asphalt laminated 3.6 to 4.5 kg kraft paper.
 - .4 Self-adhesive membrane underlay and tie-in membrane for metal flashings: To CSA A123.22 or

RLINK "http://www.techstreet.com/cgi-bin/joint.cgi/innova/cgi-bin/detail?product_id=1603735"
\o "Rev 2009 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet
Materials Used as Steep Roofing Underlayment for Ice Dam Protection"ASTM D 1970.

- .5 Sealants: in accordance with Section 07 92 00 - Joint Sealants, in colour to match flashing finish colour.
- .6 Cleats and hook strips: of same material, and temper as sheet metal, minimum 50 mm wide. Thickness same as sheet metal being secured.
 - .1 Provide continuous hook strip at outside of parapets.
- .7 Nails: of same material as sheet metal, ring thread flat head roofing nails of length and thickness suitable for metal flashing application.
- .8 Screws: of same material as sheet metal, Suitable for substrate and material being fastened, coloured head, neoprene washer.
- .11 Touch-up paint: as recommended by prefinished material manufacturer.

2.4 FABRICATION

- .1 Fabricate sheet steel flashings and other sheet steel work [in accordance with applicable CRCA'FL' series details and SMACNA architectural details.
- .2 Form pieces in 2400 mm maximum lengths.
 - .1 Make allowance for expansion at joints.
- .3 Hem exposed edges on underside 12 mm.
 - .1 Mitre and seal corners with sealant.
- .4 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .5 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.

2.5 METAL FLASHINGS

- .1 Form flashings, copings and fascias to profiles indicated of 0.6 mm thick prefinished steel.

PART-3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install sheet metal work in accordance with CRCA FL series details as indicated.

- .2 Use concealed fastenings except where approved before installation.
- .3 Provide underlay under sheet metal.
 - .1 Secure in place and lap joints 100 mm.
 - .2 Provide self-adhesive membrane to tie into adjacent assemblies.
- .4 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs.
 - .1 Flash joints using S-lock forming tight fit over hook strips, as detailed.
- .5 Lock end joints and caulk with sealant.
- .6 Install surface mounted reglets true and level, and caulk top of reglet with sealant.
- .7 Insert metal flashing under cap flashing to form weather tight junction.
- .8 Turn top edge of flashing into recessed reglet or mortar joint minimum of 25 mm. Lead wedge flashing securely into joint.
- .9 Caulk flashing at cap flashing with sealant.
- .10 Install pans, where shown around items projecting through roof membrane.
- .11 Where flashing installed with mechanical fasteners, install fasteners in slots or oversize holes to allow expansion and contraction of flashings.
- .12 Provide isolation coating or impervious self-adhesive membrane to separate aluminum items from concrete and masonry.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 00 10 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Leave work areas clean, free from grease, finger marks and stains.

END OF SECTION

Part-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 E814, Test Method for Fire Tests of Through-Penetration Fire Stops.
- .2 CAN/CGSB 19.13, Sealing Compound, One Component, Elastomeric, Chemical Curing.
- .3 CAN/ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .4 CAN/ULC S115, Standard Method of Fire Tests of Firestop Systems.
- .5 CAN/ULC S702, Thermal Insulation, Mineral Fibre for Buildings.

1.3 SUBMITTALS

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 10 00 indicating:
 - .1 Performance criteria, compliance with appropriate 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 10 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.
- .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.

1.4 QUALITY ASSURANCE

- .1 Perform 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 Conform to manufacturer's requirements and maintain a minimum temperature of 50 C for a minimum period of 24 h before application, during, and until application is fully cured.
- .2 Maintain sealant at a minimum 18E C for best workability.

Part-2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers of rated systems include:
 - .1 AD Fire Protection Systems Inc.
 - .2 Hilti Canada Corporation.
 - .3 3M Canada Inc.
 - .4 Tremco Ltd.

2.2 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 Firestop sealant: single component, low modulus, silicone rubber, moisture curing, ULC labelled to CAN/CGSB 19.13-M and CAN/ULC S115.
- .3 Firestop insulation: to CAN/ULC-S702, Type 2; mineral fibre manufactured from rock or slag, suitable for manual application.
 - .1 Density: 81 kg/m3 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.
- .4 Damming, back-up, supports, and anchorage: In accordance with manufacturer's fire rated systems and to acceptance of authorities having jurisdiction.
- .5 Primer: As recommended by firestop sealant manufacturer.

2.3 SYSTEMS

- .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 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.

Part-3 EXECUTION

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.
- .2 Verify that substrates and surfaces to receive firestopping and smoke seals are clean, dry, and frost free.

3.2 FIRESTOP AND SMOKE SEAL LOCATIONS AND RATINGS

- .1 Install ULC firestop and smoke seal systems rated to match fire resistance design rating of assemblies into which they are installed.
- .2 Install firestop and smoke seal systems. Use systems with required ratings at following typical locations, including but not limited to:
 - .1 Gaps at intersections of fire-resistance rated masonry and gypsum board partitions.
 - .2 Control and sway joints in fire-resistance rated walls and partitions such as masonry and gypsum board.
 - .3 Gaps at top of fire-resistance rated partitions such as masonry and gypsum board partitions.
 - .4 Penetrations through fire-resistance rated walls and partitions including mechanical and electrical services and openings and sleeves for future use.
 - .5 Penetrations through fire-resistance rated floor slabs, ceilings, and roofs.
 - .6 Perimeter of retaining angles on rigid ducts greater than 0.012 m², firestopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

3.3 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 Mask adjacent surfaces to avoid spillage and over-coating of adjacent surfaces. Remove stains from adjacent surfaces.

3.4 INSTALLATION

- .1 Install firestopping and smoke seal systems in accordance with 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 Repair damaged firestopped and smoke sealed surfaces to acceptance of Consultant.
- .9 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.
- .10 Do not cover materials until full cure has taken place.

3.5 CLEAN-UP

- .1 Remove excess materials and debris and clean adjacent surfaces immediately after application.

END OF SECTION

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PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 00 - Cleaning.
- .3 Section 01 74 19 - Waste Management and Disposal.
- .4 Section 01 78 00 - Closeout Submittals.

1.2 REFERENCE STANDARDS

- .1 Canadian General Standards Board (CGSB)
 - .1 CGSB 19-GP-5M, Sealing Compound, One Component, Acrylic Base, Solvent Curing (Issue of 1976 reaffirmed, incorporating Amendment No. 1).
 - .2 CAN/CGSB-19.13, Sealing Compound, One-component, Elastomeric, Chemical Curing.
 - .3 CGSB 19-GP-14M, Sealing Compound, One Component, Butyl-Polyisobutylene Polymer Base, Solvent Curing (Reaffirmation of April 1976).
 - .4 CAN/CGSB-19.17, One-Component Acrylic Emulsion Base Sealing Compound.
 - .5 CAN/CGSB-19.24, Multi-component, Chemical Curing Sealing Compound.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for joint sealants and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Manufacturer's product to describe:
 - .1 Caulking compound.
 - .2 Primers.
 - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
 - .3 Submit 2 copies of WHMIS SDS in accordance with Section.
- .3 Samples:
 - .1 Submit 2 samples of each type of material and colour.
 - .2 Cured samples of exposed sealants for each colour where required to match adjacent material.
- .4 Manufacturer's Instructions:
 - .1 Submit instructions to include installation instructions for each product used.

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1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect joint sealants from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

1.6 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Proceed with installation of joint sealants only when:
 - .1 Ambient and substrate temperature conditions are within limits permitted by joint sealant manufacturer or are above 4.4 degrees C.
 - .2 Joint substrates are dry.
 - .3 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.
- .2 Joint-Width Conditions:
 - .1 Proceed with installation of joint sealants only where joint widths are more than those allowed by joint sealant manufacturer for applications indicated.
- .3 Joint-Substrate Conditions:
 - .1 Proceed with installation of joint sealants only after contaminants capable of interfering with adhesion are removed from joint substrates.

1.7 ENVIRONMENTAL REQUIREMENTS

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Safety Data Sheets (SDS) acceptable to Health Canada.
- .2 Arrange for ventilation system to be operated on maximum outdoor air and exhaust during installation of caulking and sealants. Ventilate area of work as directed by Consultant by use of approved portable supply and exhaust fans.

PART-2 PRODUCTS

2.1 SEALANT MATERIALS

- .1 Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.
- .2 When low toxicity caulks are not possible, confine usage to areas which off gas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize off gas time.
- .3 Where sealants are qualified with primers use only these primers.

2.2 SEALANT MATERIAL DESIGNATIONS

- .1 Single component, low odor, moisture cure, medium modulus, low VOC sealant for use in sealing air/vapour barrier penetrations, to ASTM C920, Type S, Grade NS, Class 35.
 - .1 ASTM C719: $\pm 35\%$.
 - .2 Ultimate Elongation: 450 - 550%.
 - .3 Modulus, 100%: 275 - 345 kPa.
 - .4 Shore A Hardness: 25 ± 5 .
 - .5 Tensile Strength: 1034 – 1378 kPa.
 - .6 Maximum VOC: 5 g/L.
- .2 Single component, medium modulus, high-performance, neutral-cure silicone sealant for general purpose exterior use, to ASTM C920, Type S, Grade NS, Class 35, Use NT, M, A and O.
 - .1 ASTM C719: $\pm 25\%$.
 - .2 Ultimate Elongation: 550%.
 - .3 Modulus, 50% extension: 380 kPa.
 - .4 Shore A Hardness: 25 ± 5 .
 - .5 Tensile Strength: 1240 kPa.
 - .6 Maximum VOC: 35 g/L.
- .3 Single component, low modulus, neutral-cure silicone sealant for general purpose masonry use, to ASTM C920, Type S, Grade NS, Class 50, Use T, NT, M, G, A and O.
 - .1 ASTM C719: $\pm 50\%$.
 - .2 Ultimate Elongation: 1600%.
 - .3 Modulus, 50% extension: 193 kPa.
 - .4 Shore A Hardness: 15.
 - .5 Tensile Strength: 690 kPa.
 - .6 Maximum VOC: 22 g/L.
- .4 Two-component, high modulus, neutral-cure flexible silicone rubber sealant for use with aluminum window and curtain wall fabrication, assembly and glazing installation, to ASTM C1184 and ASTM C920, Type M, Grade NS, Class 12 ½, Use NT.
 - .1 ASTM C719: $\pm 25\%$.
 - .2 Ultimate Elongation: 120%.
 - .3 Shore A Hardness: 30 - 40.
 - .4 Tensile Strength: 2000 kPa.

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- .5 Maximum VOC: < 18 g/L.
- .5 Single component, medium modulus, neutral-cure silicone sealant for general roofing applications, to ASTM C920, Type S, Grade NS, Class 50, Use NT, G, A and O.
 - .1 ASTM C719: $\pm 50\%$.
 - .2 Shore A Hardness: 35.
 - .3 Tensile Strength: 415 kPa.
 - .4 Maximum VOC: 28 g/L.
 - .5 Colour to be selected from manufacturer's standard range.
- .6 Single component, chemical cure, silicone rubber sealant, for use with plumbing fixtures, showers, sinks, tubs, and junction of counter tops and adjacent wall finishes, to ASTM C920, Type S, Grade NS, Class 25, Use NT.
 - .1 Shore A Hardness: 25.
 - .2 Tensile Strength: 2100 kPa.
 - .3 Maximum VOC: 36 g/L.
 - .4 Colour to be selected from manufacturer's standard range.
- .7 Single component, high-performance, elastomeric polyurethane sealant, paintable, for general purpose interior use, to ASTM C920, Type S, Grade NS, Class 35, Use NT, M, A, T, O and I.
 - .1 ASTM C719: 35%.
 - .2 Ultimate Elongation: 800%.
 - .3 Shore A Hardness: 25 - 30.
 - .4 Tensile Strength: 2400 kPa.
 - .5 Maximum VOC: 35 g/L.
 - .6 Colour to be selected from manufacturer's standard range.
- .8 Single component, non-skinning, non-hardening, synthetic rubber sealant for use in acoustical applications, to CAN/CGSB 19.21.
 - .1 Shrinkage: maximum 20%.
 - .2 Maximum VOC: 53 g/L.
 - .3 Sag: Maximum 4.0 mm.
- .9 Two-component, non-sag, tamper resistant, elastomeric polyurethane sealant, for use in interior joints, penetrations, doors, windows, perimeters of fixtures, where a flexible security sealant is required due to idle tampering or vandalism, to ASTM C920, type M, Grade NS, Class 12.5, Use T1, M and O.
 - .1 Ultimate Elongation: 175 - 200%.
 - .2 Shore A Hardness: 40 - 45.
 - .3 Tensile Strength: 2000 to 2400 kPa.
 - .4 Maximum VOC: Activator - < 25 g/L, Base - < 100 g/L.
 - .5 Colour to be selected from manufacturer's standard range.

2.3 ACCESSORIES

- .1 Primer: Type as recommended by sealant manufacturer. Primer to be compatible with joint forming materials.

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- .2 Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer and compatible with joint forming materials.
- .3 Preformed Compressible and Non-Compressible back-up materials.
 - .1 Polyethylene, Urethane, Neoprene or Vinyl Foam.
 - .1 Extruded closed cell foam backer rod.
 - .2 Size: oversize 30 to 50 %.
 - .2 Neoprene or Butyl Rubber.
 - .1 Round solid rod, Shore A hardness 70.
 - .3 High Density Foam.
 - .1 Extruded closed cell polyvinyl chloride (PVC), extruded polyethylene, closed cell, Shore A hardness 20, tensile strength 140 to 200 kPa, extruded polyolefin foam, 32 kg/m³ density, or neoprene foam backer, size as recommended by manufacturer.
 - .4 Bond Breaker Tape.
 - .1 Polyethylene bond breaker tape which will not bond to sealant.

PART-3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for joint sealants installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 SURFACE PREPARATION

- .1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
- .2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work.
- .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
- .4 Ensure joint surfaces are dry and frost free.
- .5 Prepare surfaces in accordance with manufacturer's directions.

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3.3 PRIMING

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.4 BACKUP MATERIAL

- .1 Apply bond breaker tape where required to manufacturer's instructions.
- .2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

3.5 MIXING

- .1 Mix materials in strict accordance with sealant manufacturer's instructions.

3.6 APPLICATION

- .1 Sealant:
 - .1 Apply sealant in accordance with manufacturer's written instructions.
 - .2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
 - .3 Apply sealant in continuous beads.
 - .4 Apply sealant using gun with proper size nozzle.
 - .5 Use sufficient pressure to fill voids and joints solid.
 - .6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
 - .7 Tool exposed surfaces before skinning begins to give slightly concave shape.
 - .8 Remove excess compound promptly as work progresses and upon completion.
- .2 Curing:
 - .1 Cure sealants in accordance with sealant manufacturer's instructions.
 - .2 Do not cover up sealants until proper curing has taken place.

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Clean adjacent surfaces immediately.
 - .3 Remove excess and droppings, using recommended cleaners as work progresses.
 - .4 Remove masking tape after initial set of sealant.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

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3.8 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by joint sealants installation.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 01 00 10 - General Requirements.
- .2 08 71 00 - Doors Hardware.
- .3 08 80 00 - Glazing.
- .4 09 91 13 - Exterior Painting.
- .5 09 91 23 - Interior Painting.

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM A 653/A 653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
 - .2 CGSB 41-GP-19Ma, Rigid Vinyl Extrusions for Windows and Doors.
- .3 CSA Group (CSA)
 - .1 CSA-G40.20 /G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .4 Canadian Steel Door Manufacturers' Association (CSDMA)
 - .1 CSDMA, Recommended Specifications for Commercial Steel Doors and Frames.
 - .2 CSDMA, Selection and Usage Guide for Commercial Steel Doors.
- .5 National Fire Protection Association (NFPA)
 - .1 NFPA 80, Standard for Fire Doors and Fire Windows.
 - .2 NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S702, Standard for Thermal Insulation, Mineral Fibre, for Buildings.
 - .2 CAN4-S104, Standard Method for Fire Tests of Door Assemblies.

1.3 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Design exterior frame assembly to accommodate expansion and contraction when subjected to minimum and maximum surface temperature of -35 degrees C to 35 degrees C.
 - .2 Steel fire rated doors and frames: labelled and listed by an organization accredited by Standards Council of Canada in conformance with CAN4-S104 or NFPA 252 for ratings specified or indicated.
 - .3 Provide fire labelled frames for openings requiring fire protection ratings. Test products in conformance with CAN4-S104, ASTM E 152 or NFPA 252 and listed by nationally recognized agency having factory inspection services.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Indicate each type of door, material, steel core thicknesses, mortises, reinforcements, location of exposed fasteners, openings, glazed, louvred, arrangement of hardware and fire rating and finishes.
 - .3 Indicate each type frame material, core thickness, reinforcements, glazing stops, location of anchors and exposed fastenings and reinforcing, fire rating, and finishes.
 - .4 Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and door schedule.
- .3 Provide samples in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Submit one 305 x 305 mm corner sample of each type of frame.
 - .1 Show butt cutout, glazing stops, 305 mm long snap-on trim with clips.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store, and handle materials in accordance with Section Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Hot dipped galvanized steel sheet: to ASTM A 653M, ZF75, minimum base steel thickness in accordance with CSDMA Table 1 - Thickness for Component Parts
- .2 Reinforcement channel: to CSA G40.20/G40.21, Type 44W, coating designation to ASTM A 653M, ZF75.

2.2 DOOR CORE MATERIALS

- .1 Honeycomb construction:
 - .1 Structural small cell, 24.5 mm maximum kraft paper 'honeycomb', weight: 36.3 kg per ream minimum, density: 16.5 kg/m³ minimum sanded to required thickness.
- .2 Stiffened: face sheets welded, insulated core.
 - .1 Fibreglass: to CAN/ULC-S702, fibrous insulation minimum density 48 kg/m³.

2.3 ADHESIVES

- .1 Honeycomb cores and steel components: heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.
- .2 Lock-seam doors: fire resistant, resin reinforced polychloroprene, high viscosity,

sealant/adhesive.

2.4 PRIMER

- .1 Touch-up prime CAN/CGSB-1.181.

2.5 PAINT

- .1 Field paint steel doors and frames in accordance with Sections 09 91 23 - Interior Painting, 09 91 13 - Exterior Painting. Protect weatherstrips from paint. Provide final finish free of scratches or other blemishes.

2.6 ACCESSORIES

- .1 Door silencers: single stud rubber/neoprene type.
- .2 Exterior and interior top and bottom caps: rigid polyvinylchloride extrusion conforming to CGSB 41-GP-19Ma.
- .3 Fabricate glazing stops as formed channel, minimum 16 mm height, accurately fitted, butted at corners and fastened to frame sections with counter-sunk oval head sheet metal screws.
- .4 Metallic paste filler: to manufacturer's standard.
- .5 Fire labels: metal rivited.
- .6 Sealant: in accordance with Section 07 92 00 - Joint Sealants.
- .7 Glazing: in accordance with Section 08 80 00 - Glazing.
- .8 Make provisions for glazing as indicated and provide necessary glazing stops.
 - .1 Provide removable stainless steel glazing beads for [use with glazing tapes and compounds and secured with countersunk stainless-steel screws.
 - .2 Design exterior glazing stops to be tamperproof.

2.7 FRAMES FABRICATION GENERAL

- .1 Fabricate frames in accordance with CSDMA specifications.
- .2 Fabricate frames to profiles and maximum face sizes as indicated.
- .3 Exterior frames: 1.6 mm thermally broken type construction.
- .4 Interior frames: 1.6 mm welded type construction.
- .5 Blank, reinforce, drill and tap frames for mortised, templated hardware, and using templates provided by finish hardware supplier. Reinforce frames for surface mounted hardware.
- .6 Protect mortised cutouts with steel guard boxes.
- .7 Prepare frame for door silencers, 3 for single door, 2 at head for double door.
- .8 Manufacturer's nameplates on frames and screens are not permitted.

- .9 Conceal fastenings except where exposed fastenings are indicated.
- .10 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.
- .11 Insulate exterior frame components with polyurethane insulation.

2.8 DOOR FABRICATION GENERAL

- .1 Doors: swing type, flush, with provision for glass and/or louvre openings as indicated.
- .2 Exterior doors: honeycomb construction. Interior doors: hollow steel construction.
- .3 Fabricate doors with longitudinal edges locked seam, welded. Seams: grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish.
- .4 Doors: manufacturers' proprietary construction, tested and/or engineered as part of a fully operable assembly, including door, frame, gasketing and hardware in accordance with ASTM E 330.
- .5 Blank, reinforce, drill doors and tap for mortised, templated hardware and electronic hardware.
- .6 Factory prepare holes 12.7 mm diameter and larger except mounting and through-bolt holes, on site, at time of hardware installation.
- .7 Reinforce doors where required, for surface mounted hardware. Provide flush steel top caps to exterior doors. Provide inverted, recessed, spot welded channels to top and bottom of interior doors.
- .8 Provide factory-applied touch-up primer at areas where zinc coating has been removed during fabrication.
- .9 Provide fire labelled doors for those openings requiring fire protection ratings, as scheduled. Test such products in conformance with CAN4-S104, ASTM E 152, NFPA 252 and list by nationally recognized agency having factory inspection service and construct as detailed in Follow-Up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.
- .10 Manufacturer's nameplates on doors are not permitted.

2.9 THERMALLY BROKEN DOORS AND FRAMES

- .1 Fabricate thermally broken doors by using insulated core and separating exterior parts from interior parts with continuous interlocking thermal break.
- .2 Thermal break: rigid polyvinylchloride extrusion conforming to CGSB 41-GP-19Ma.
- .3 Fabricate thermally broken frames separating exterior parts from interior parts with continuous interlocking thermal break.
- .4 Apply insulation.

PART 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 GENERAL

- .1 Install labelled steel fire rated doors and frames to NFPA 80 except where specified otherwise
- .2 Install doors and frames to CSDMA Installation Guide

3.3 FRAME INSTALLATION

- .1 Set frames plumb, square, level and at correct elevation.
- .2 Secure anchorages and connections to adjacent construction.
- .3 Brace frames rigidly in position while building-in. Install temporary horizontal wood spreader at third points of door opening to maintain frame width. Provide vertical support at centre of head for openings over 1200 mm wide. Remove temporary spreaders after frames are built-in.
- .4 Make allowances for deflection of structure to ensure structural loads are not transmitted to frames.
- .5 Caulk perimeter of frames between frame and adjacent material.
- .6 Maintain continuity of air barrier and vapour retarder.

3.4 DOOR INSTALLATION

- .1 Install doors and hardware in accordance with hardware templates and manufacturer's instructions and Section 08 71 00 - Doors Hardware.
- .2 Provide even margins between doors and jambs and doors and finished floor and thresholds as follows.
 - .1 Hinge side: 1.0 mm.
 - .2 Latch side and head: 1.5 mm.
 - .3 Finished floor, noncombustible sill and thresholds: 13 mm.
- .3 Adjust operable parts for correct function.
- .4 Install louvres.

3.5 FINISH REPAIRS

- .1 Touch up with primer finishes damaged during installation.
- .2 Fill exposed frame anchors and surfaces with imperfections with metallic paste filler and sand to a uniform smooth finish.

3.6 GLAZING

- .1 Install glazing for doors and frames in accordance with Section 08 80 00 - Glazing.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements.

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)
 - .1 ANSI/BHMA A156.16, Auxiliary Hardware.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements.
- .2 Provide product data: in accordance with Section 01 00 10 - General Requirements.
- .3 Provide shop drawings: in accordance with Section 01 00 10 - General Requirements.
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Indicate assembly details, material, thickness, hardware attachments and accessories.
- .4 Provide samples: in accordance with Section 01 00 10 - General Requirements.
- .5 Closeout Submittals:
 - .1 Provide maintenance data for flexible doors and hardware and components for incorporation into manual specified in Section 01 00 10 - General Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Store products in manufacturer's unopened packaging with seals and labels intact until ready for installation.
- .2 Store materials off the ground in a dry, warm, ventilated, weathertight location.
- .3 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Acceptable Manufacturers: Wayne Dalton.
 - .1 Acceptable product: Model 800 Rolling Service Doors, Stainless Steel.
- .2 Curtain: composed of interlocking roll-formed slats.
 - .1 Slat Profiles/Material:
 - .1 Flat-faced slat, 18-gauge stainless steel.
 - .2 Ends of alternate slats fitted with metal endlocks/windlocks.

- .3 Bottom Bar: Consists of two equal stainless-steel angles, 3 mm minimum thickness, to stiffen curtain, with astragal.
- .4 Guides:
 - .1 Roll-formed steel channel bolted to three structural angle guide angle assembly forming a slot to retain curtains in guides. Structural grade, three angle assembly fabricated of stainless steel.
- .5 Brackets: Design to enclose ends of coil and provide support for counterbalance pipe at each end. Fabricate of steel plates minimum 5 mm thickness, with permanently sealed ball bearings.
- .6 Counterbalance: Curtain to coil on pipe of sufficient size to carry door load with minimum deflection.
 - .1 Correctly balanced curtain by helical springs, oil tempered torsion type.
 - .2 Use cast iron barrel plugs to anchor springs to tension shaft and pipe.
- .7 Hood: Enclose curtain coil and counterbalance mechanism. Fabricate of Minimum 24-gauge stainless steel, flanged at top for attachment to header and flanged at bottom to provide longitudinal stiffness.
- .8 Finish: Shop coat of rust inhibitive primer on non-galvanized surfaces and operating mechanisms. Coat guides and bracket plates with flat black prime paint.
 - .1 Stainless Steel, #4 finish.
- .9 Operation: Motor operation with electrical sensing edge attached to bottom bar to stop and reverse door when it contacts an object during the closing cycle.
- .10 Weatherstripping: Bottom astragal, optional surface guide weatherstrip, and internal hood baffle.
- .11 Locking: Electric-motor operation doors provided with lock through the operator gearing.
- .12 Mounting: Steel jambs.

2.2 CONSTRUCTION

- .1 Construct flexible doors of flexible panels and metal framing members.
- .2 Provide hardware for 135 degrees swing in both directions.

PART-3 EXECUTION

3.1 EXAMINATION

- .1 Do not begin installation until substrates have been properly prepared.
- .2 Examine conditions of substrates, supports, and other conditions under which this work is to be performed.
- .3 If substrate preparation is the responsibility of another installer, notify Consultant of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- .1 Clean surfaces thoroughly prior to installation.
- .2 Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- .1 Install in accordance with manufacturer's written instructions.
- .2 Install door complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports in accordance with final shop drawings, and manufacturer's instructions.
- .3 Fit, align and adjust rolling door assemblies level and plumb for smooth operation.
- .4 Upon completion of final installation, lubricate, test and adjust doors to operate easily, free from warp, twist or distortion and fitting for entire perimeter.

3.4 ADJUSTING

- .1 Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.
- .2 Adjust hardware and operating assemblies for smooth and noiseless operation.

3.5 CLEANING

- .1 Clean curtain and components using non-abrasive materials and methods recommended by manufacturer.
- .2 Remove labels and visible markings.
- .3 Touch-up, repair or replace damaged products before Substantial Completion.

3.6 PROTECTION

- .1 Protect installed products until completion of project.
- .2 Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

Part-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 611, Voluntary Standards for Anodized Architectural Aluminum.
- .2 AAMA CW-10, Care and Handling of Architectural Aluminum from Shop to Site.
- .3 AAMA CW I-9, Aluminum Curtain Wall Design Guide Manual.
- .4 CAN/CSA-A440-M/A440.1-M, Windows / User Selection Guide to CSA Standard CAN/CSA A440-M Windows.
- .5 CSA A440/A440.1, Windows, Special Publication.
- .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 F738M, Specification for Stainless Steel Metric Bolts, Screws, and Studs.
- .15 CAN/CGSB 1.108-M, Bituminous Solvent Type Paint.
- .16 CAN/CGSB 79.1-M, Insect Screens.
- .17 CAN/ULC S702, Thermal Insulation, Mineral Fibre, for Buildings.

1.3 DEFINITIONS

- .1 Aluminum Work: Shall mean aluminum curtainwall, windows, clerestory skylights, entrances, vestibules, screens, doors, bifold ventilators, sunshades, and framing mentioned in Part 2 of this Specification Section.

1.4 DESIGN REQUIREMENTS

- .1 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.
- .2 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.
- .3 Design to prevent accumulation of condensate on interior side of Aluminum Work framing under the following service conditions:
 - .1 Interior temperature: 25°C.
 - .2 Exterior temperature: -20°C.
 - .3 Interior RH: 35%.
- .4 Design windows in accordance with following CSA A440/A440.1 classification ratings:
 - .1 Air tightness: A3, fixed.
 - .2 Water tightness: B7.
 - .3 Wind load resistance: C5.
 - .4 Temperature Index: I57.
 - .5 Forced Entry: F2.
 - .6 Insect Screens: S2.
- .5 Restrict air infiltration/exfiltration, through Aluminum Work in accordance with ASTM E283 at pressure differential as indicated:
 - .1 Curtainwalls and entrance assemblies: 0.0003 m³/s m² at differential of 300 Pa.
 - .2 Sloped glazing/skylights: 0.0003 m³/s m² at differential of 500 Pa.
 - .3 Doors (per door): 2.78 m³/h m per linear metre of crack at differential of 75 Pa.
- .6 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.
- .7 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.

- .8 Prevent deflection and permanent or progressive glazing displacement. Restrict horizontal and vertical mullion deflection to less than $L/175$ (under uniformly distributed positive design wind load), and 10 mm maximum regardless of span.
- .9 Design anchorage inserts for installation as part of other Sections of Work. Design anchorage assemblies to accommodate construction and installation tolerances.
- .10 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.
- .11 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.
- .12 Design sunshade to conform to the following:
 - .1 Design sunshade to be fully cantilevered (i.e. no tie-back struts) and integral to the Aluminum Work.
 - .2 Deflection max; deflection of any member shall not exceed $L/200$ or 10 mm whichever is less.
 - .3 Design load, use windgust pressure calculated from National Building Code using 1-100 year return.
 - .4 The shade and structure shall take a temperature difference of 85°C without putting stresses on any member or sealants.
 - .5 Design each module to support 115 kg with a maximum 20 mm deflection.

1.5 SUBMITTALS

- .1 Shop drawings:
 - .1 Submit shop drawings for all Aluminum Work in accordance with Section 01 10 10 indicating:
 - .1 Plans, sections, details, type of extrusions, profiles, finishes, panels, operating components, doors, related flashings, closures, fillers, and end caps, and sealants.
 - .2 Products and glazing types.
 - .3 Anchorage inserts, system installation tolerances.
 - .4 Section and hardware reinforcement, anchorage, assembly fixings.
 - .5 Detailing, locations, and allowances for movement, expansion, contraction
 - .6 Path of cavity drainage and air pressure equalization.
- .2 Samples:
 - .1 Submit two samples of following in accordance with Section 01 10 10.
 - .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 Submit documentation to substantiate ten years of experience in aluminum window and door manufacture and installation.
- .4 Close-out submittals: Submit window data for incorporation into the Operations and Maintenance Manual as part of Section 01 10 10.

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 Review, stamp, and sign shop drawings.
 - .3 Conduct on-Site inspections and prepare and submit inspection reports.
- .2 Mock-up:
 - .1 Fabricate, deliver, and erect one, full scale mock-up of each type of Aluminum Work, in location acceptable to Consultant.
 - .2 Demonstrate full range of Products, finishes, textures, quality of fabrication, and 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Handle Aluminum Work in accordance with AAMA CW-10.
- .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 Submit a warranty for Aluminum Work in accordance with General Conditions, except that warranty period is extended to Five (5) years.
 - .1 Warrant against failure to meet design criteria and requirements, including but not limited to, material and workmanship, water and air leakage, structural failure, deterioration, weathering, defects, sealant, malfunction under normal usage, and frame condensation.
 - .2 Coverage: Complete replacement including affected adjacent Work.

- .2 Submit a separate warranty in accordance with the General Conditions, except that warranty period is extended to Ten (10) years.
 - .1 Warrant factory sealed double glazed insulating units are warranted against leakage, malfunction and other defects, under normal usage. Without restricting the generality of the warranty, defects to the insulating units shall include warping of spacer bars by greater than 3 mm; dust or film formation on internal glass surfaces; glass breakage except that caused by thermal shock and impact of solid objects; deterioration of glass coatings, including thermal properties.
 - .2 Coverage: Complete replacement including affected adjacent Work.

Part-2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND SYSTEMS

- .1 Curtainwall: 'VersaWall 2500 Series' by Alumicor Limited, '1600 Curtainwall' by Kawneer Company Canada Limited, or approved alternative.
- .2 Aluminum windows: 'FeatureLine 990 Series' by Alumicor Limited, '5500 Isoport Windows' by Kawneer Company Canada Limited, or approved alternative.
- .3 Aluminum entrance/storefront framing: '3400 Series' by Alumicor Limited or 'Trifab VG 451T' by Kawneer Company Canada Limited or approved alternative.
- .4 Vestibule framing: '1800 Series' by Alumicor Limited or 'Trifab VG 451' by Kawneer Company Canada Limited or approved alternative.
- .5 Aluminum doors:
 - .1 Interior:
 - .1 'Series 100A Canadiana' by Alumicor Limited.
 - .2 '190 Series' by Kawneer Company Canada Limited.
 - .3 Or approved alternative.
 - .2 Exterior:
 - .1 'Series 100A Insuldoor' by Alumicor Limited.
 - .2 '260 Insulclad Doors' by Kawneer Company Canada Limited.
 - .3 Or approved alternative.

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 1.29 mm for sheets less than 610 mm wide and minimum 2.05 mm for sheets of a greater dimension.

- .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: 'Soprascel Stick 1100' by Soprema Inc., 'Exoair 110' by Tremco or 'Air-Shield' by W.R. Meadows. Membrane to come complete with applicable primer.
- .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 curtain wall extrusion finish.
- .14 Screws, bolts and other fasteners: ASTM F738M; Stainless Steel Type 304.
- .15 Isolation coating: CAN/CGSB-1.108-M; Bitumastic coating, acid and alkali resistant material.
- .16 Spandrel panel insulation: CAN/ULC S702; Semi-rigid mineral fibre.
 - .1 Type 703 by Owens-Corning.
 - .2 CurtainRock by Roxul Inc.
 - .3 Thickness: As required to fill void.
 - .4 Insulation fasteners: Stik-Clip with retaining washer.
- .17 Spray Foam Insulation: CFC free, polyurethane foam in place, closed cell low expansion, one component, minimum density 15 kg/m3.
 - .1 'ENERFOAM' by Dow Chemical Canada.
 - .2 'IPF All Weather Pro' by Rivenco Industries.
- .18 Window hardware: Manufacturer's standard heavy-duty stainless-steel hardware.

- .19 Door hardware: Supplied by finish hardware supplier under Section 08 70 00 for installation by door manufacturer.
- .20 Insect screen: Extruded aluminum frames containing heavy duty, fine fibreglass mesh in accordance with CSA A440. Screen to be retained in place with turn clip type fixings. Provide samples for the Consultant's approval.
- .21 Weatherstripping: Durable, non-absorbing material resistant to deterioration by aging and weathering.

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 panel system in accordance with reviewed shop drawings.
- .3 Fabricate, fit, and secure framing joints and corners accurately, with flush surfaces, and hairline joints. Apply frame sealant at joints for weatherproof seams.
- .4 Conceal anchors, reinforcement, and attachments from view. Fabricate reinforcement in accordance with design requirements.
- .5 Provide additional reinforcing in mullions for sunshades as required.
- .6 Do not expose manufacturer's identification labels on aluminum assemblies.
- .7 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.
- .8 Certify aluminum windows as complying with the CAN/CSA-A440-M/A440.1-M design criteria and requirements using an easily removable label located on the inside face of glazing.
- .9 Position operable windows on main frame to provide direction of opening specified, free and smooth operation, without binding or sticking against main frame members.
- .10 Fabricate doors and frames complete with internal reinforcements, cut-outs, and recesses to accommodate finish hardware. Reinforce cut-outs to assure adequate strength.
- .11 Fabricate Aluminum Work closures and trim from aluminum sheet. Form to profile shown. Make weathertight.
- .12 Double weatherstrip windows and doors. Install weatherstripping in specially extruded ports and secure to prevent shrinkage or movement.
- .13 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 SPANDREL PANELS

- .1 Fabricate insulated spandrel panel inner facing of 0.9 mm aluminum sheet. Wrap edges with aluminum sheet, enabling installation and minor movement of perimeter seal.
- .2 Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.
- .3 Place insulation within panel, adhered to exterior face of interior panel sheet over entire area of sheet with impale fasteners.
- .4 Provide integral reinforcing and stiffeners as required to reinforce panel against deflection caused by wind and suction loads.
- .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 thickness to be as indicated, 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.

2.6 FINISH

- .1 Extrusion finish: Clear anodized to AAMA 611 per Aluminum Association Designation System for Aluminum Finishes AA-M12C22A31. Kawneer #14 finish.
- .2 Doors: Clear anodized to AAMA 611 per Aluminum Association Designation System for Aluminum Finishes AA-M12C22A41. Kawneer #14 finish.
- .3 Panel and sheet finish: As indicated on drawings to match adjacent extrusion finish.

Part-3 EXECUTION

3.1 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 Install aluminum door manufacturer's standard weatherstripping at door frame perimeter. Install weatherstripping throughout entire length and width of doors at jambs and heads.
- .9 Install doors and hardware to manufacturers' written instructions. Clean and adjust hardware for correct performance.
- .10 Adjust operable parts for correct function.
- .11 Remove damaged or unacceptable Products and assemblies from Site and replace to Consultant's acceptance.
- .12 Install glass presence markers, in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 00 - Cleaning.
- .3 Section 01 74 19 - Waste Management and Disposal.
- .4 Section 01 78 00 - Closeout Submittals.

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI) / Builders Hardware Manufacturers Association (BHMA)
 - .1 ANSI/BHMA A156.1, American National Standard for Butts and Hinges.
 - .2 ANSI/BHMA A156.2, Bored and Preassembled Locks and Latches.
 - .3 ANSI/BHMA A156.13, Mortise Locks and Latches Series 1000.
 - .4 ANSI/BHMA A156.17-2004, Self-closing Hinges and Pivots.
 - .5 ANSI/BHMA A156.18-2006, Materials and Finishes.
- .2 Canadian Steel Door and Frame Manufacturers' Association (CSDMA)
 - .1 CSDMA Recommended Dimensional Standards for Commercial Steel Doors and Frames - 2009.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for door hardware and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Samples will be returned for inclusion into work.
 - .3 Identify each sample by label indicating applicable specification paragraph number, brand name and number, finish and hardware package number.
 - .4 After approval samples will be returned for incorporation in Work.
- .4 Hardware List:
 - .1 Submit contract hardware list.
 - .2 Indicate specified hardware, including make, model, material, function, size, finish and other pertinent information.
- .5 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .6 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for door hardware for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials:
 - .1 Supply maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Tools:
 - .1 Supply 2 sets of wrenches for door closers, locksets and fire exit hardware.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements:
 - .1 Hardware for doors in fire separations and exit doors certified by a Canadian Certification Organization accredited by Standards Council of Canada.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Package items of hardware including fastenings, separately or in like groups of hardware, label each package as to item definition and location.
- .4 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 door hardware from nicks, scratches, and blemishes.
 - .3 Protect prefinished surfaces with wrapping strippable coating.
 - .4 Replace defective or damaged materials with new.
- .5 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 HARDWARE ITEMS

- .1 Use one manufacturer's products only for similar items.

2.2 DOOR HARDWARE

- .1 Locks and latches:
 - .1 Refer to Appendix A – Door Hardware & Ket Specifications Guidelines - City of Richmond Hill.
 - .2 Mortise locks and latches: to ANSI/BHMA A156.2, series 4000 bored lock, grade 1, designed for function and keyed as stated in Hardware Schedule.
 - .3 Lever handles: Refer to Appendix A.
 - .4 Normal strikes: box type, lip projection not beyond jamb.
 - .5 Cylinders: Refer to Appendix A.
 - .6 Finished to 626.
- .2 Butts and hinges:
 - .1 Butts and hinges: to CAN/CGSB-69.18, designated by letter A and numeral identifiers, followed by size and finish, listed in Hardware Schedule.
- .3 Door Closers and Accessories:
 - .1 Door controls (closers): to CAN/CGSB-69.20, designated by letter C and numeral identifiers listed in Hardware Schedule, size in accordance with CAN/CGSB-69.20, table A1, finished to 689.
- .4 Architectural door trim: to CAN/CGSB-69.22, designated by letter J and numeral identifiers listed in Hardware Schedule as listed below, finished to 626.
 - .1 Door protection plates: kick plate type, 200 mm x width of door, 1.27 mm thick stainless steel (or aluminum for entry door) finished to 626.
 - .2 Weatherstripping: by KN Crowder
- .5 Doorstops:
 - .1 Provide dome floor or wall stop for every opening listed in schedule. Stops finished to 626.

2.3 FASTENINGS

- .1 Use only fasteners provided by manufacturer. Failure to comply may void warranties and applicable licensed labels.
- .2 Supply screws, bolts, expansion shields and other fastening devices required for satisfactory installation and operation of hardware.
- .3 Exposed fastening devices to match finish of hardware.
- .4 Where pull is scheduled on one side of door and push plate on other side, supply fastening devices, and install so pull can be secured through door from reverse side. Install push plate to cover fasteners.
- .5 Use fasteners compatible with material through which they pass.

2.4 KEYING

- .1 Prepare detailed keying schedule in conjunction with Consultant.

- .2 Supply construction cores and construction keys, during construction phase.
- .3 Permanent cores will be provided and installed by a City approved rostered Locksmith vendor.
 - .1 Approved Vendors:
 - .1 Protect Security.
 - .2 Royal Security
 - .3 Reilly Locks

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Supply metal door and frame manufacturers with complete instructions and templates for preparation of their work to receive hardware.
- .3 Supply manufacturers' instructions for proper installation of each hardware component.
- .4 Install hardware to standard hardware location dimensions in accordance with CSDFMA Canadian Metric Guide for Steel Doors and Frames (Modular Construction)
- .5 Where door stop contacts door pulls, mount stop to strike bottom of pull.
- .6 Install key control cabinet.
- .7 Use only manufacturer's supplied fasteners.
 - .1 Use of "quick" type fasteners, unless specifically supplied by manufacturer, is unacceptable.
- .8 Remove construction cores and locks when directed by Consultant.
 - .1 Install permanent cores and ensure locks operate correctly.

3.2 ADJUSTING

- .1 Adjust door hardware, operators, closures and controls for optimum, smooth operating condition, safety and for weather tight closure.
- .2 Lubricate hardware, operating equipment and other moving parts.
- .3 Adjust door hardware to ensure tight fit at contact points with frames.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Clean hardware with damp rag and approved non-abrasive cleaner, and polish hardware in accordance with manufacturer's instructions.
 - .3 Remove protective material from hardware items where present.
 - .4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 DEMONSTRATION

- .1 Keying System Setup and Cabinet:
 - .1 Set up key control system with file key tags, duplicate key tags, numerical index, alphabetical index and key change index, label shields, control book and key receipt cards.
 - .2 Place file keys and duplicate keys in key cabinet on their respective hooks.
 - .3 Lock key cabinet and turn the key over to Consultant.
- .2 Maintenance Staff Briefing:
 - .1 Brief maintenance staff regarding:
 - .1 Proper care, cleaning, and general maintenance of projects complete hardware.
 - .2 Description, use, handling, and storage of keys.
 - .3 Use, application and storage of wrenches for door closers, locksets and fire exit hardware.
- .3 Demonstrate operation, operating components, adjustment features, and lubrication requirements.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by door hardware installation.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements.
- .2 Section 07 92 00 - Joint Sealants.

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM C 542, Standard Specification for Lock-Strip Gaskets.
 - .2 ASTM D 2240, Standard Test Method for Rubber Property - Durometer Hardness.
 - .3 ASTM E 330, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-12.1, Tempered or Laminated Safety Glass.
 - .2 CAN/CGSB-12.3, Flat, Clear Float Glass.
 - .3 CAN/CGSB-12.8, Insulating Glass Units.
- .3 Glass Association of North American (GANA)
 - .1 GANA Glazing Manual.
 - .2 GANA Laminated Glazing Reference Manual.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Preinstallation Meetings:
 - .1 Convene preinstallation meeting 1 week prior to beginning work of this Section and on-site installation, with Contractor's Representative and Consultant:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Coordination with other building subtrades.
 - .4 Review manufacturer's written installation instructions and warranty requirements.
- .2 Arrange for site visit with Consultant prior to start of Work to examine existing site conditions adjacent to demolition Work.
- .3 Hold project meetings every month.
- .4 Ensure key personnel, site supervisor, project manager, subcontractor representatives attend.
- .5 Consultant will submit written notification of change to meeting schedule established upon contract award 24 hours prior to scheduled meeting.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for glass,

sealants, and glazing accessories and include product characteristics, performance criteria, physical size, finish and limitations.

- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .4 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Samples will be returned for inclusion into work.
 - .3 Submit duplicate 300 x 300 mm size samples of glazing, mirror and sealant material.
- .5 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .6 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
 - .1 Submit testing and analysis of glass under provisions of Section 01 00 10 - General Requirements.
 - .2 Submit shop inspection and testing for glass.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Operation and Maintenance Data: submit operation and maintenance data for glazing for incorporation into manual.

1.6 QUALITY ASSURANCE

- .1 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .2 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 00 10 - General Requirements.
 - .2 Construct mock-up to include glass glazing, and perimeter air barrier and vapour retarder seal.
 - .3 Mock-up will be used:
 - .1 To judge quality of work, substrate preparation, operation of equipment and material application.
 - .4 Locate where directed.
 - .5 Allow 24 hours for inspection of mock-up before proceeding with work.
 - .6 When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work when directed by Consultant.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging,

labelled with manufacturer's name and address.

- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect glazing and frames from nicks, scratches, and blemishes.
 - .3 Protect prefinished aluminum surfaces with wrapping and strippable coating.
 - .4 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in accordance with Section 01 00 10 - General Requirements.

1.8 AMBIENT CONDITIONS

- .1 Ambient Requirements:
 - .1 Install glazing when ambient temperature is 10 degrees C minimum. Maintain ventilated environment for 24 hours after application.
 - .2 Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Design Criteria:
 - .1 Ensure continuity of building enclosure vapour and air barrier using glass and glazing materials as follow:
 - .1 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.
 - .2 Size glass to withstand wind loads, dead loads and positive and negative live loads acting normal to plane of glass to ASTM E 330.
 - .3 Limit glass deflection to 1/200 with full recovery of glazing materials.
- .2 Flat Glass:
 - .1 Float glass: to CAN/CGSB-12.3, glazing quality, 5 mm thick.
 - .2 Silvered mirror glass: 4 mm thick.
 - .1 Type 1A-float glass for normal use.
- .3 Insulating Glass Units:
 - .1 Insulating glass units: to CAN/CGSB-12.8, double unit, 23 mm overall thickness.
 - .1 Glass: to CAN/CGSB-12.1, tempered.
 - .2 Glass thickness: 6 mm each light.
 - .3 Inter-cavity space thickness: 13 mm with low conductivity spacers.
 - .4 Glass coating: surface number 2, low "E".
 - .5 Inert gas fill: argon.
 - .6 Colour: Medium grey.
 - .7 Bird Safe or Frit: As selected by Consultant.
- .4 Sealant: in accordance with Section 07 92 00 - Joint Sealants.

2.2 ACCESSORIES

- .1 Setting blocks: neoprene, 80-90 Shore A durometer hardness to ASTM D 2240, minimum 100 mm x width of glazing rabbet space minus 1.5 mm x height.
- .2 Spacer shims: neoprene, 50-60 Shore A durometer hardness to ASTM D 2240, 75 mm long x one half height of glazing stop x thickness to suit application. Self-adhesive on one face.
- .3 Glazing tape:
 - .1 Preformed butyl compound with integral resilient tube spacing device, 10-15 Shore A durometer hardness to ASTM D 2240; coiled on release paper; black colour.
- .4 Glazing splines: resilient polyvinyl chloride, extruded shape to suit glazing channel retaining slot, colour as selected.
- .5 Glazing clips: manufacturer's standard type.
- .6 Lock-strip gaskets: to ASTM C 542.
- .7 Mirror attachment accessories:
 - .1 Mirror frames: stainless steel.
 - .2 Clips: stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for glazing installation in accordance with manufacturer's written instructions.
 - .1 Verify that openings for glazing are correctly sized and within tolerance.
 - .2 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.
 - .3 Visually inspect substrate in presence of Consultant.
 - .4 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .5 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

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: INTERIOR - DRY TAPE

- .1 Perform work in accordance with GANA Glazing Manual and GANA Laminated Glazing Reference Manual for glazing installation methods.

- .2 Cut glazing tape to length and set against permanent stops, projecting 1.6 mm above sight line.
- .3 Place setting blocks at 1/4 points, with edge block maximum 150 mm from corners.
- .4 Rest glazing on setting blocks and push against tape for full contact at perimeter of light or unit.
- .5 Place glazing tape on free perimeter of glazing in same manner described.
- .6 Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
- .7 Knife trim protruding tape.

3.4 INSTALLATION: MIRRORS

- .1 Set mirrors with adhesive, applied in accordance with adhesive manufacturer's instructions.
- .2 Set mirrors with clips. Anchor rigidly to wall construction.
- .3 Set in frame.
- .4 Place plumb and level.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements.
 - .1 Leave Work area clean at end of each day.
 - .1 Remove traces of primer, caulking.
 - .2 Remove glazing materials from finish surfaces.
 - .3 Remove labels.
 - .4 Clean glass and mirrors using approved non-abrasive cleaner in accordance with manufacturer's instructions.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 After installation, mark each light with an "X" by using removable plastic tape or paste.
 - .1 Do not mark heat absorbing or reflective glass units.
- .3 Repair damage to adjacent materials caused by glazing installation.

END OF SECTION

Part-1 General

1.1 RELATED SECTIONS

- .1 Section 06 10 00 - Rough Carpentry.
- .2 Section 07 21 16 - Blanket Insulation.
- .3 Section 07 92 00 - Joint Sealants.
- .4 Section 09 22 16 - Non-Structural Metal Framing.
- .5 Section 09 91 23 - Interior Painting.

1.2 REFERENCE STANDARDS

- .1 American Society for Testing and Materials (ASTM International).
 - .1 ASTM C473-19, Standard Test Methods for Physical Testing of Gypsum Panel Products.
 - .2 ASTM C475/C475M-17, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - .3 ASTM C840-20, Standard Specification for Application and Finishing of Gypsum Board.
 - .4 ASTM C919-19. Standard Practice for Use of Sealants in Acoustical Applications.
 - .5 ASTM C954-18, Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
 - .6 ASTM C1002-20, Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - .7 ASTM C1047-19, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
 - .8 ASTM C1177/C1177M-17, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - .9 ASTM C1178/C1178M-18, Standard Specification for Glass Mat Water-Resistant Gypsum Backing Board.
 - .10 ASTM C1280-18, Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing.
 - .11 ASTM C1396/C1396M-17, Standard Specification for Gypsum Board.
 - .12 ASTM C1629/C1629M-19, Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.
 - .13 ASTM D3273-16, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
- .2 Association of the Wall and Ceilings Industries International (AWCI).
 - .1 AWCI GA-214-2015 Recommended Levels of Gypsum Board Finish.
- .3 Underwriters Laboratories of Canada (ULC).
 - .1 CAN/ULC-S604:2016, Standard for Factory-Built Type A Chimneys.

- .2 CAN/ULC-S702.1:2014-AMD1, Standard for Mineral Fibre Thermal Insulation for Buildings, Part 1: Material Specification First Amendment to Third Edition.
- .3 CSA B149.1-15 with 2017 Ontario Amendments, Natural Gas and Propane Installation Code.
- .4 Gypsum Association (GA).
 - .1 GA 216, Application and Finishing of Gypsum Panel Products.

1.3 SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging.
- .3 Storage and Handling Requirements:
 - .1 Store gypsum board assemblies' materials level off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect gypsum board assemblies from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.5 AMBIENT CONDITIONS

- .1 Maintain temperature 10 degrees Celsius minimum, 21 degrees Celsius maximum for 48 hours before and during application of gypsum boards and joint treatment, and for 48 hours minimum after completion of joint treatment.
- .2 Apply board and joint treatment to dry, frost free surfaces.
- .3 Ventilation: Ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

Part-2 Products

2.1 MATERIALS

- .1 Standard Board: To ASTM C1396/C1396M, Type X, 12.7 and 15.9 mm thick as indicated, 1 220 mm wide by maximum practical length, ends square cut, edges bevelled. CGC and CertainTeed are approved manufacturers.
- .2 Moisture / Mould / Abuse Resistant Board: To ASTM C1396/C1396M, ASTM C473, ASTM C1629, 15.9 mm thick, Type X, 1 220 mm wide by maximum practical length.

- .1 Moisture Resistance: To ASTM C473, not greater than 5 percent after 2 hours.
- .2 Mould Resistance: to ASTM D32373, score 10.
- .3 Abuse Resistance: to ASTM C1629.
 - .1 Abrasion: Level 3.
 - .2 Indentation: Level 1.
 - .3 Soft Body Impact: Level 2.
 - .4 Hard Body Impact: Level 1.
- .4 Backer wallboard for shower walls (walls to receive wall tile): Diamondback by CertainTeed or Durock by CGC.
- .3 Glass Mat Water-Resistant Gypsum Backing Board: to ASTM C1178/C1178M, 16 mm thick, 1 220 mm wide x maximum practical length. Mould resistance score 10 in accordance with ASTM D3273.
 - .1 Acceptable Products: Custom Building Products Wonderboard Backerboard; CGC Fiberock Aqua-Tough Tile Backerboard, CertainTeed Diamondback GlasRoc Tile Backer, Georgia-Pacific DensShield Tile Backer.
- .4 Metal furring runners, hangers, tie wires, inserts, anchors: To ASTM C1280, galvanized.
- .5 Resilient Gypsum Board Furring: 0.5 mm base steel thickness galvanized steel for resilient attachment of standard gypsum board. Use 0.91 mm for abuse/water resistant board.
- .6 Steel Drill Screws:
 - .1 For wood and metal framing: To ASTM C1002, except as indicated.
 - .2 For metal framing 0.91 mm and thicker: To ASTM C954.
- .7 Casing beads, corner beads, control joints and edge trim: to ASTM C1047, metal, zinc-coated by hot-dip process, 0.5 mm base thickness, perforated flanges, one-piece length per location.
- .8 Acoustic Insulation: Refer to Section 07 21 16 – Blanket Insulation.
- .9 Sealants: In accordance with Section 07 92 00 - Joint Sealants.
- .10 Insulating Strip: Rubberized, moisture resistant, 3 mm thick closed cell neoprene strip, 12 mm wide, with self-sticking permanent adhesive on one face, lengths as required.
- .11 Joint Compound: Durabond 90 to ASTM C475, asbestos-free.
- .12 Joint Tape:
 - .1 Standard Board: Paper.
 - .2 Moisture/Mould/Abuse Resistant Board: Glass mesh.
 - .3 Glass Mat Water-Resistant: Glass mesh.
 - .4 Tile Backing Panels: As recommended by panel manufacturer.
- .13 Access Doors:
 - .1 Access Door Type **AD1**: Wall application recessed Access Door in public areas. Designed for flush installation in gypsum board and plaster wall assemblies while providing an invisible architectural appearance. Provide Access Door with factory installed layer of 16 mm GWB.
 - .1 Material: mill finish aluminum.

- .1 Mounting frame: recessed aluminum angle extrusion.
 - .2 Door: recessed aluminum angle extrusion, rounded safety corners, concealed hinges, key operated cylinder cam latch, abloy compatible, anchor straps, fitted with layer of 16 mm GWB. Door panel: removable.
- .2 Access Door Type **AD2**: Wall application recessed access door for back-of-house areas. Designed for flush installation in gypsum board and plaster wall assemblies.
 - .1 Material: 1.2 mm cold rolled steel, paint finish.
 - .1 Mounting frame: recessed 1.2 mm cold rolled steel, exposed flanged.
 - .2 Door: recessed aluminum angle extrusion, rounded safety corners, concealed hinges, screwdriver latch, anchor straps, fitted with layer of 1 6mm GWB. Door panel: removable.
- .3 Access Door Type **AD3**: Floor application recessed access door for back-of-house areas. Designed for flush installation in concrete floor assemblies.
 - .1 Material: 6mm aluminum diamond plate, no finish.
 - .1 Mounting frame: recessed 50 x 50 mm x 6 mm aluminum angle.
 - .2 Door: recessed aluminum angle extrusion, square corners, concealed heavy duty aluminum piano hinge, 2.03 mm, recessed handle operated cam latch.
- .4 Access Door Type **AD4**: Ceiling application recessed Access Door for back-of-house areas. Designed for flush installation in gypsum board and plaster wall assemblies.
 - .1 Material: 0.9 mm Galvannealed steel door, white powder coat primer, paint finish.
 - .1 Mounting frame: 1.2 mm cold rolled steel frame, recessed, 76mm deep with 25 mm exposed flange.
 - .2 Door: upward opening, recessed galvanneal steel, rounded safety corners, concealed piano hinge, hex head slam latch outside with self-latching ring operated slam latch inside.
- .5 Sizes: refer to drawings for locations and sizes of all architectural access doors.
- .6 All access doors to be fire rated in accordance with fire separation plans.
- .7 All interior access doors to be uninsulated unless indicated otherwise by STC requirements.
- .14 Perimeter gypsum board trim at linear metal ceiling junctions:
 - .1 Straight two-piece pre-engineered and pre-finished extruded aluminum gypsum board trim, 102 mm high, integrated and pre-punched tapping flange for gypsum board attachment, colour to later selection to manufacturer's full colour range. Refer to drawings. Inside corners to be mitered at 45 degrees.

Part-3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for gypsum board assemblies' installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 ERECTION

- .1 Do application and finishing of gypsum board to ASTM C840 except where specified otherwise.
- .2 Erect hangers and runner channels for suspended gypsum board ceilings to ASTM C840 except where specified otherwise.
- .3 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.
- .4 Install work level to tolerance of 1:1200.
- .5 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers and grilles.
- .6 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.
- .7 Acoustic insulation:
 - .1 Install insulation to maintain continuity acoustical separation.
 - .2 Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.
 - .3 Do not compress insulation to fit into spaces.
 - .4 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN/ULC-S604 Type A chimneys and CSA B149.1 Type B and L vents.

3.3 APPLICATION – GYPSUM BOARD

- .1 Apply gypsum board after bucks, anchors, blocking, sound attenuation, electrical and mechanical work have been approved.
- .2 Apply gypsum board to metal framing or furring using screw fasteners for all layers. Maximum spacing of screws 300 mm on centre.
 - .1 Single-Layer Application:
 - .1 Apply gypsum board on ceilings before application of walls to ASTM C840.
 - .2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.
 - .2 Double-Layer Application:

- .1 Install gypsum board for base layer and exposed gypsum board for face layer.
 - .2 Apply base layers at right angles to supports unless otherwise indicated.
 - .3 Apply base layer with joints over supports and face layer joints offset at least 250 mm with base layer joints.
- .3 Apply water-resistant gypsum board where epoxy paint to be applied and as indicated on plans. Apply water-resistant sealant to edges, ends, cut-outs which expose gypsum core and to fastener heads.
- .4 Apply glass mat water-resistant gypsum backing board where wall tiles to be applied. Apply water-resistant sealant to edges, ends, cut-outs which expose gypsum core and to fastener heads.
 - .1 Joint treatment: To Section 09 30 00 - Tile.
- .5 Install ceiling boards in direction that will minimize number of end-butt joints. Stagger end joints at least 250 mm.
- .6 Install gypsum board on walls vertically to avoid end-butt joints. At high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.
- .7 Install gypsum board with face side out.
- .8 Do not install damaged or damp boards.
- .9 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 APPLICATION - SEALANT

- .1 STC-Rated Assemblies:
 - .1 Seal construction at full periphery of partitions, behind control joints, at openings, and penetrations with 12 mm continuous bead of acoustical sealant.
 - .2 Install acoustical sealant at each gypsum board layer in assembly except:
 - .1 For double-layer gypsum board application install maximum two continuous beads, one at each base layer.
 - .3 Comply with ASTM C919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around and through assemblies, including sealing partitions above acoustical ceilings.

3.5 INSTALLATION

- .1 Provide a 6 mm gap at the bottom edge of gypsum board sheets where they abut concrete slabs, in accordance with the standard GA 216.
- .2 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150 mm on centre.
- .3 Install casing beads around perimeter of suspended ceilings.
- .4 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.

- .5 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.
- .6 Construct control joints of preformed units set in gypsum board facing and supported independently on both sides of joint.
- .7 Locate control joints where indicated, at changes in substrate construction, at approximate 10 m spacing on runs greater than 20 m, and at approximate 15 m spacing on ceilings.
- .8 Install control joints straight and true.
- .9 Install access doors to electrical and mechanical fixtures specified in respective sections.
 - .1 Rigidly secure frames to furring or framing systems.
- .10 Finish face panel joints and internal angles with joint system consisting of 2 coats of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.
- .11 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI GA-214 Levels of Gypsum Board Finish:
 - .1 Levels of finish:
 - .1 Level 0: No tapping, finishing or accessories required.
 - .1 Location: temporary construction, behind solid paneling where fire or smoke seal is not required.
 - .2 Level 1: embed tape for joints and interior angles in joint compound. Surfaces to be free of excess joint compound; tool marks and ridges are acceptable.
 - .1 Location: gypsum board above ceilings, interior side of exterior walls above finished ceilings. Concealed fire separations.
 - .3 Level 2: embed tape for joints and interior angles in joint compound and apply one separate coat of joint compound over joints, angles, fastener heads and accessories; surfaces free of excess joint compound; tool marks and ridges are acceptable.
 - .1 Location: gypsum board behind rigid wall protection, and at Glass mat water-resistant gypsum backing board installed as tile backer
 - .4 Level 4: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges.
 - .1 Location: where gypsum board is to be painted except as indicated below.
- .12 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.
- .13 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board to be invisible after surface finish is completed.
- .14 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.

- .15 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.

3.6 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 00 10 - General Requirements.
 - .1 Leave Work area clean at end of each day.
 - .2 Ensure gypsum board surfaces are clean and free of dirt to the satisfaction of the Owner and Consultant before beginning with painting operations.
 - .3 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by gypsum board assemblies' installation.

3.8 SCHEDULES

- .1 Construct ULC fire rated assemblies where indicated.
- .2 Refer to Partition Type Schedule on drawings.

END OF SECTION

Part-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 ASTM C144, Specification for Aggregate for Masonry Mortar.
- .3 CAN/CSA A3000, Cementitious Materials Compendium.
- .4 CAN/CGSB 25.20, Surface Sealer for Floors.
- .5 CGSB 71-GP-22M, Organic Adhesive for Installation of Ceramic Wall Tile.
- .6 TTMAC Specification Guide 09300 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 10 10 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 10 10 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 10 10.
 - .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 Closeout submittals: Submit recommended maintenance instructions and listing of recommended maintenance Products for incorporation into Operations and Maintenance Manuals in accordance with Section 01 10 10.

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.
- .2 Shower area system:
 - .1 All work related to the Latricrete shower area system is to be carried out by a single Contractor who is to be responsible for the complete installation of the system from the concrete surface to the completed finished installation.
 - .2 This work is not to be divided to multiple contractors.

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: 150C to 450C.
 - .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.

1.8 EXTENDED WARRANTY

- .1 Submit a written warranty for shower area system in accordance with the General Conditions, except that warranty period is extended to 10 years.
 - .1 Warrant Work against water leakage and failure to perform.
 - .2 Coverage: Complete replacement including effected adjacent Work.

Part-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:
 - .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 Refer to List of Materials for tile types.
- .3 Divider Strip: Stainless steel edge, continuous at all exposed tile edges, depth as required to suit tile thickness. 'Schiene-E' by Schluter Systems or approved alternative

2.2 ACCESSORIES

- .1 Cement: CAN/CSA A3000, Type 10.
- .2 Sand: ASTM C144.
- .3 Water: Potable and free of minerals and other contaminants which are detrimental to mortar and grout mixes.
- .4 Polymer additive: Keralastic by Mapei Inc or approved alternative by Flextile Ltd. or Laticrete International.
- .5 Pre-mixed thin-set mortar: ANSI A108/A118/A136.1:
 - .1 'Kerabond with Keralastic Latex Additive' by Mapei Inc. or approved alternative by Flextile Ltd. or Laticrete International unless otherwise recommended by grout manufacturer to suit tile size or application.
 - .2 White coloured mortar shall be provided at appropriate tile types including, but not limited to; glass tile, light coloured marble, green marble and light coloured granite.
- .6 Thick bed sloped topping: Factory mixed blend of portland cement and aggregates with latex admix. '226 thick bed mortar with 3701 admix' by Laticrete or approved alternative by Mapei Inc.
- .7 Shower area system: Provide the following system for use at shower areas as manufactured by Laticrete or approved alternative by Mapei Inc.:
 - .1 Adhesive: Polymer fortified, thin-set mortar complete with antimicrobials. 254 by Laticrete.
 - .2 Mortar bed: Factory mixed blend of portland cement and aggregates with latex admix. 226 thick bed mortar with 3701 admix by Laticrete.
 - .3 Waterproofing: Single component, self curing liquid rubber polymer. Hydro Ban by Laticrete.
 - .4 Finish: As indicated on Interior Design Schedule.
 - .5 Epoxy grout: High performance sanded epoxy grout 'SpectraLOCK Pro Grout'

by Laticrete in colour as selected by Consultant.

- .8 Primer: To meet specified requirements of adhesive manufacturer.
- .9 Cleaner: In accordance with TTMAC's requirements and as recommended by tile manufacturer.
- .10 Waterproof Membrane: Waterproof Membrane System made from black, cold-applied, self-curing, liquid rubber polymer and an integral reinforcing fabric. 'Mapelastic' by Mapei or '9235 Waterproofing' by Laticrete International Inc.
- .11 Organic adhesive (walls): CGSB 71-GP-22M, Type 1.
- .12 Grout:
 - .1 Floors and bases (below 3 mm joint width): 'Keracolor U' by Mapei Inc. or approved alternative by Flextile Ltd. or Laticrete International.
 - .2 Floors and bases (3 mm to 10 mm joint width): 'Ultra/Color' by Mapei Inc. or approved alternative by Flextile Ltd. or Laticrete International.
 - .3 Walls (1.5 mm to 3 mm joint width): 'Ker 800' by Mapei Inc. or approved alternative by Flextile Ltd. or Laticrete International.
 - .4 Walls (over 3 mm joint width): 'Ultra/Colour' by Mapei Inc. or approved alternative by Flextile Ltd. or Laticrete International.
 - .5 Grout colour: To be selected by the Consultant from the manufacturer's full colour range.
- .13 Joint backing: Round, closed cell, foam rod, oversized by 30% to 50%, Shore A hardness of 20, tensile strength 140 to 200 kPa.
- .14 Sealer: CAN/CGSB-25.20, penetrating, type as recommended by tile manufacturer.
- .15 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.

Part-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.

3.4 SHOWER AREA SYSTEM

- .1 Install mortar bed over thin set adhesive on uneven substrate surfaces, level and plumb substrates in accordance with manufacturer's written instructions and having 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 Provide slopes to drains as indicated on drawings.
- .3 Apply waterproofing with a spray applicator on prepared substrate to a total dry film thickness of 0.8 mm in accordance with manufacturer's printed directions. Carry up walls to 50 mm high.

- .4 Install finish materials after site inspection by manufacturer, ensuring that materials have been installed correctly and in accordance with manufacturers written instructions. Provide written inspection report verifying manufacturer's warranty of system.
- .5 Apply Grout for shower area system in accordance with epoxy grout manufacturer's directions to produce watertight, filled joints without voids, cracks and excess grout. Thoroughly compact and tool grout. Finish grout flush to edge thickness of tile and remove excess grout with soft burlap or sponge moistened with clean water.

3.5 WATERPROOFING MEMBRANE

- .1 Apply with a trowel on prepared substrate to a total dry film thickness of 1.143 mm in accordance with manufacturer's printed directions. Carry up walls to 50 mm high.

3.6 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.
 - .2 100% for large format tile.
- .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, base and wall grout joints.
- .8 Install tile accessory fittings for a complete and fully coordinated tile assembly.
- .9 Install wall tile full height unless indicated otherwise.
- .10 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.
- .11 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.

- .12 Do not proceed with grouting until minimum 48 hours after tile has set, to prevent displacement of tiles.
- .13 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.

3.7 CLEANING

- .1 Clean off excess grout with soft burlap or sponge moistened with clean water.
- .2 Polish floor and wall 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 ceramic 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.

3.8 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.

3.9 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

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 43 00 - Quality Assurance.
- .3 Section 01 74 00 - Cleaning.
- .4 Section 01 74 19 - Waste Management and Disposal.
- .5 Section 01 78 00 - Closeout Submittals.

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM C 423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
 - .2 ASTM E 580/E 580M Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions.
 - .3 ASTM C 635/C 635M, Standard Specifications for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
 - .4 ASTM C 636/C 636M, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
 - .5 ASTM E 1264, Standard Classification for Acoustical Ceiling Products.
 - .6 ASTM E 1414/E 1414M, Standard Test Method for Sound Attenuation between Rooms Sharing a Common Ceiling Plenum.
 - .7 ASTM E 1477, Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction and Amendment No. 1.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .4 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.

1.3 COORDINATION

- .1 Do not begin erection of ceiling suspension system until work above ceiling has been inspected by Consultant.

1.4 PREINSTALLATION MEETING

- .1 Convene preinstallation meeting one week prior to beginning work of this Section and on-site installation, with contractor's representative and other affected trades to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.

- .3 Coordination with work of other sections.
- .4 Review manufacturer's installation instructions and warranty requirements.
- .5 Review accepted shop drawings for installation requirements.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for acoustical suspension, acoustic panels, acoustic tiles, and system accessories. Include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit reflected ceiling plans for special grid patterns as indicated.
 - .2 Indicate lay-out, insert and hanger spacing and fastening details, splicing method for main and cross runners, location of access splines, change in level details, access door dimensions, and locations and acoustical unit support at ceiling fixture lateral bracing and accessories.
- .4 Delegated Design Submittals:
 - .1 Submit delegated design shop drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Indicate components and installation methods to conform to specified seismic design and construction requirements of Contract Documents and in general accordance with ASTM E 580/E 580M.
 - .3 Include supporting details, treatment of cross runners, main runners, and wall closures at terminal ends, suspension wire, lateral force bracing, light fixtures and services within the ceiling, seismic isolation joints and partition bracing.
- .5 Samples:
 - .1 Submit for review and acceptance of each component specified or necessary for complete installation. Include technical descriptive data.
 - .2 Submit duplicate samples of each component proposed for use in each type of ceiling suspension system.
 - .3 Submit duplicate full-size samples of each type of acoustical unit.

1.6 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit operation and maintenance data for acoustical suspension for incorporation into manual.
- .3 Submit final certificate from design professional responsible for delegated detail design of ceiling indicating conformity with accepted shop drawings.

1.7 MAINTENANCE MATERIALS

- .1 Provide extra acoustical units in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide acoustical units amounting to 2% of gross ceiling area for each pattern and type of

acoustical panel or tile, suspension system and trim required for project, minimum 1 complete factory-sealed package of each.

- .3 Ensure extra materials are from same production run as installed materials.
- .4 Deliver extra materials for each type of acoustical unit in original unopened packages clearly identified, including colour and texture.
- .5 Deliver to Owner, upon completion of the work of this section.

1.8 CERTIFICATIONS

- .1 Fire-resistance rated suspension system: certified by a Canadian Certification Organization accredited by Standards Council of Canada.
- .2 Certifications: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements. Include certification of sustainable requirements.

1.9 MOCK-UPS

- .1 Construct mock-ups in accordance with Section 01 43 00 - Quality Assurance.
- .2 Construct mock-up 10 m² minimum of each type acoustical ceiling assembly including one inside corner and one outside corner. Ceiling system mock-up to show basic construction and assembly, treatment at walls, recessed fixtures, splicing, interlocking, finishes, acoustical unit installation, seismic reinforcing.
- .3 Construct mock-up where directed.
- .4 Allow 24 hours for inspection of mock-up by Consultant before proceeding with ceiling work.
- .5 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of the finished work.

1.10 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials flat, off ground, indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect acoustical ceiling panels, tiles and suspension grid components from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .4 Store extra materials required for maintenance, where directed by Consultant.
- .4 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling or disposal in accordance with Section

01 74 19 - Waste Management and Disposal.

1.11 ENVIRONMENTAL REQUIREMENTS

- .1 Permit wet work to dry before beginning to install.
- .2 Maintain uniform minimum temperature of 15 degrees C and humidity of 20-40% before and during installation.
- .3 Store materials in work area 48 hours prior to installation.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

- .1 Design Requirements:
 - .1 Intermediate duty system to ASTM C 635/ASTM C635M.
 - .2 Maximum deflection: 1/360th of span to ASTM C 635/ASTM C635M deflection test.

2.2 MANUFACTURERS

- .1 Acceptable Manufacturers: Provide products from: Armstrong Ceilings, CGC Inc.

2.3 ACOUSTICAL CEILING SUSPENSION

- .1 Acoustical Ceiling Suspension system: non fire rated, made up as follows:
 - .1 2-directional exposed tee bar grid.
- .2 Basic materials for suspension system: commercial quality cold rolled steel mill finished.
- .3 Exposed tee bar grid components: shop painted satin sheen white. Components die cut. Main tee with double web, rectangular bulb and 25 mm rolled cap on exposed face. Cross tee with rectangular bulb; web extended to form positive interlock with main tee webs; lower flange extended and offset to provide flush intersection.
- .4 Hanger wire: galvanized soft annealed steel wire:
 - .1 3.6 mm diameter for access tile ceilings.
 - .2 To ULC design requirements for fire rated assemblies.
 - .3 2.6 mm diameter for other ceilings.
- .5 Hanger inserts: purpose made.
- .6 Carrying channels: 38 x 19 mm channel, of painted steel.
- .7 Accessories: splices, clips, wire ties, retainers and wall moulding reveal, to complement suspension system components, as recommended by system manufacturer.

2.4 ACOUSTICAL CEILING PANELS

- .1 Acoustical Panel: to ASTM E1264 and as follows.
 - .1 Type: 12.

- .2 Pattern Designation: E.
- .3 Fire Classification: Class A.
 - .1 Flame spread rating of 25 or less in accordance with CAN/ULC-S102.
 - .2 Smoke developed 50 or less in accordance with CAN/ULC-S102.
- .4 Noise Reduction Coefficient (NRC) designation of 0.90. Sound Absorption Average (SAA) of 0.9 to ASTM C 423.
- .5 Ceiling Attenuation Class (CAC) rating 26, in accordance with ASTM E 1414.
- .6 Light Reflectance (LR) range of 0.88 to ASTM E 1477.
- .7 Edge type square edge.
- .8 Colour: white.
- .9 Size: 610 x 610 x 25 mm thick.
- .10 Shape: flat.

2.5 ACCESSORIES

- .1 Spacers: galvanized wire acoustical media supports, crimped and welded, to allow 13 mm space between back of unit and acoustical media.
- .2 Polyethylene: to CAN/CGSB-51.34, 0.15 mm thick.
- .3 Hold down clips: purpose made clips to secure panel/tile to suspension system, approved for use in fire-rated systems.
- .4 Edge trim for floating ceilings: Sheet metal channels, finished to match suspension grid, straight or curved to radius indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verify conditions of substrates previously installed under other Sections or Contracts are acceptable for acoustical ceiling tile and track installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INTERFACE WITH OTHER WORK

- .1 Coordinate ceiling work to accommodate components of other sections, such as light fixtures, diffusers, speakers, sprinkler heads, to be built into acoustical ceiling components.

3.3 SUSPENSION SYSTEM INSTALLATION

- .1 Comply with manufacturer's written installation instructions and recommendations, including product technical bulletins, product carton installation instructions, and data sheets.
- .2 Install suspension system in accordance with accepted shop drawings, Certification Organizations tested design requirements and ASTM C 636/C 636M except where specified otherwise.

- .3 Layout centre line of ceiling both ways, to provide balanced borders at room perimeter with border units not less than 50% of standard unit width, system according to reflected ceiling plan.
- .4 Finished ceiling system to be square with adjoining walls and level within 1:1000.
- .5 Secure hangers to overhead structure using attachment methods as indicated.
- .6 Install hangers spaced at maximum 1200 mm centres and within 150 mm from ends of main tees.
- .7 Ensure suspension system is coordinated with location of related components. Provide carrying channels as necessary to bridge at unavoidable interference between suspension system and other work above ceiling.
- .8 Install wall moulding to provide correct ceiling height.
- .9 Completed suspension system to support super-imposed loads, such as lighting fixtures, diffusers, grilles and speakers.
- .10 Support at light fixtures and diffusers with additional ceiling suspension hangers within 150 mm of each corner and at maximum 610 mm around perimeter of fixture.
- .11 Attach cross member to main runner to provide rigid assembly.
- .12 Frame at openings for light fixtures, air diffusers, speakers and at changes in ceiling heights.
- .13 Install access splines to provide 50% ceiling access.
- .14 Expansion joints:
 - .1 Erect two main runners parallel, 50 mm apart, on building expansion joint line. Lay in strip of acoustic tile/board, painted black, 25% narrower than space between 2 "T" bars.
 - .2 Supply and install "Z" shaped metal trim pieces at each side of expansion joint. Design to accommodate plus or minus 25 mm movement and maintain visual closure. Finish metal components to match adjacent exposed metal trim. Provide backing plates behind butt joints.
- .15 Install perimeter trim at floating installations securely anchored to suspension system, in accurate alignment with adjacent assemblies. Install curved trim members in smooth curves to radius indicated.

3.4 ACOUSTICAL CEILING PANEL INSTALLATION

- .1 Install lay-in acoustical panels in ceiling suspension system in accordance with manufacturer's instructions and as indicated.
- .2 Install fibrous acoustical media and spacers over entire area above suspended metal panels.
- .3 In fire rated ceiling systems, secure lay-in panels with hold-down clips and protect over light fixtures, diffusers, air return grilles and other appurtenances according to Certification Organizations design requirements.

3.5 SITE QUALITY CONTROL

- .1 Arrange for periodic site visits by design professional responsible for delegated ceiling design

work to review installed work for conformity to design.

- .2 Arrange for periodic site visits by manufacturer's representative to review installed work for conformity to manufacturer's installation instructions and recommendations.
- .3 Submit written site reports by designer to Consultant within 3 days of visit.

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 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 01 74 00 - Cleaning.
 - .1 Touch up scratches, abrasions, voids and other defects in painted surfaces.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

3.7 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by acoustical suspension installation.

END OF SECTION

Part-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 F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- .3 ASTM F 2170, Standard Test Method for Determining Relative Humidity in Concrete Slabs Using in-situ Probes.
- .4 ASTM F2195, Standard Specification for Linoleum Tile Flooring.

1.3 SUBMITTALS

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 10 10 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 10 10:
 - .1 Two 250 x 200 mm samples of each type of tile material and colour.
 - .2 Two 250 mm long samples of each base, accessory and colour.
- .3 Closeout submittals: Submit maintenance and cleaning data for incorporation into Operations and Maintenance Manuals in accordance with Section 01 10 10.

1.4 SITE CONDITIONS

- .1 Maintain air temperature and structural base temperature at flooring installation area above 20oC 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 and base required for maintenance use. Identify each carton. Store where directed.

PART-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 Linoleum composition tile (LST): ASTM F2195, Type 1; minimum 330 x 330 x 2.0 mm thick with polyester backing, refer to List of Materials for colour types. 'Marmoleum Composition Tile (MCT)' by Forbo Flooring or approved alternative.
- .3 Conductive Vinyl Tile (VSDT): CSA A126.2-M, Type A, mottled, asbestos free, 305 x 305 x 3 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 List of Materials for colour type.
 - .6 Acceptable products and manufacturers:
 - .1 'Excelon SDT' by Armstrong.
 - .2 'ElectroStatic' by Amtico.
- .4 Stair treads: Rubber treads with a raised round profile complete with a 50 mm wide contrasting solid rubber colour insert strip at nose of tread. Tread shall have a tapered thickness of 5.33 mm to 2.87 mm complete with a 50 mm hinged square nose, colour to later selection of Consultant from manufacturer's full colour range; 'Roundel Rubber Stair Tread VIRH' by Johnsonite or approved alternative by nora systems, Inc.
- .5 Resilient Base: In accordance with Section 09 65 16.
- .6 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.
- .7 Primers and adhesives: Low VOC, waterproof, recommended by flooring manufacturer for specific material on applicable substrate, above, at or below grade.
- .8 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.
- .9 Sealer and wax: Type recommended by flooring manufacturer.

Part-3 EXECUTION

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.
- .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 TILE APPLICATION

- .1 Install resilient tile flooring in accordance with manufacturer's written instructions.
- .2 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.

- .3 Lay flooring with joints straight and parallel to building lines to produce symmetrical tile pattern. Install equal size perimeter tile on each side.
- .4 Install flooring to square grid pattern with all joints aligned.
- .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 reducing edge strips at unprotected or exposed edges where flooring terminates and at edges where there are two finishes of different thicknesses.
- .11 Install rubber base in accordance with Section 09 65 16.

3.4 STAIR TREADS

- .1 Prepare adhesive and install materials in accordance with manufacturer's written instructions.
- .2 Pre-cut and fit treads prior to spreading adhesive. Fill back side of tread nose with a caulking bead; brush on adhesive on understeps and back of treads, as well as back of risers, and on receiving substrate. Allow to become tacky to touch before installing. Treads shall be fully bonded to substrate, with tread nosing butted tight against stair tread nosing. Roll with hand roller after installation.
- .3 Remove adhesive seepage at seams or surface while adhesive is still wet, in accordance with manufacturer's recommendations.

3.5 CLEANING AND WAXING

- .1 Forty-eight hours after installation, clean vinyl tile surfaces with a mild soap solution approved by finish manufacturer. Rinse clean, dry and apply 2 coats of wax. Polish thoroughly.

3.6 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 waxed and 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

Part-1 GENERAL

1.1 SECTION INCLUDES

- .1 Labour, Products, equipment and services necessary for carpet Work in accordance with the Contract Documents.

1.2 REFERENCES

- .1 Canadian Carpet Institute (CCI), Contract Carpet Manual, No. 001.

1.3 SUBMITTALS

- .1 Product data:
 - .1 Submit two copies of manufacturer's Product data for each product specified in accordance with Section 01 00 10 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 00 10 indicating:
 - .1 Carpeted floor areas, carpet selection, pile direction, location and direction of seams, cross joints, and other details required by Consultant to clarify work.
- .3 Samples:
 - .1 Submit following samples in accordance with Section 01 00 10.
 - .1 Submit duplicate 300 mm square pieces of underpad, and each type carpet specified, 300 mm long pieces of carpet base and cap strip, 150 mm lengths of moulding.
- .4 Certification:
 - .1 Submit certification that carpet has been tested and passed the Indoor Air Quality (IAQ) Carpet Testing Program requirements of the Canadian Carpet Institute.
 - .2 Four weeks after Notification of Award, Submit certification from carpet manufacturer that carpet has been ordered.
 - .3 Submit program parameters for recycling.
- .5 Closeout submittals: Submit maintenance and cleaning data for incorporation into Operations and Maintenance Manuals in accordance with Section 01 00 10.

1.4 SITE CONDITIONS

- .1 Do not install Work of this Section when the ambient air and surface temperature is below 180C or above 400C without Consultant's and Product manufacturer's written acceptance.
- .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.

1.5 MAINTENANCE

- .1 Submit extra 3% each colour, pattern and type of flooring material required for maintenance use. Extra materials to be from same production run as installed materials and clearly labelled. Provide in one continuous full width roll. Store where directed.
- .2 Upon completion of the work of this Section, bundle and wrap all large remnant pieces of carpet remaining and store where directed by Consultant.

Part-2 PRODUCTS

2.1 GENERAL

- .1 General: All materials under Work of this Section, including but not limited to, adhesives are to have low VOC content limits.

2.2 MATERIALS

- .1 Carpet tile (CT): Refer to List of Materials for Carpet tile types.
- .2 Seaming tape: Types recommended by carpet manufacturer for purpose intended.
- .3 Adhesive: Non-release type: recommended by carpet manufacturer for direct glue down installation, low odour, free of volatile hydrocarbons such as toluene and mineral spirits.
- .4 Reducing edge strips, thresholds: Nitrile rubber plasticized vinyl, 80-95 Shore A Durometer, adhesive as recommended by manufacturer.
- .5 Thresholds:
 - .1 Provide carpet threshold 'CD-XX' by Johnsonite or approved alternative where carpets of different colours meet.
 - .2 Provide carpet threshold 'VT-XX-M' by Johnsonite or approved alternative where carpet abuts edge of ceramic/porcelain tile.
 - .3 Provide carpet threshold 'CTA-XX' by Johnsonite or approved alternative where carpet abuts resilient tile and sheet flooring.
 - .4 Provide carpet threshold 'EG-XX' by Johnsonite or approved alternative at exposed carpet edges.
- .6 Carpet protection: Non-staining heavy duty kraft paper.
- .7 Base: In accordance with Section 09 65 16.
- .8 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.

Part-3 EXECUTION

3.1 PREPARATION

- .1 Verify substrate surfaces are solid, free from surface water, dust, oil, grease, scaling or laitance, projections and other foreign matter detrimental to performance.
- .2 Repair depressions and cracks with latex base compound or water putty crack filler. Sweep and vacuum surfaces before laying carpet.
- .3 Pre-condition carpeting following manufacturer's printed instructions.

3.2 INSTALLATION

- .1 Install floor carpet in accordance with pattern layout and reviewed shop drawings, manufacturer's printed instructions and in accordance with Contract Carpet Manual, Standard for Installation of Textile Floor covering Materials No. 001.
- .2 Adhesive method:
 - .1 Apply adhesive and install carpeting in accordance with manufacturer's written instructions by direct glue-down method. Install carpet with pile in same direction throughout a given floor area. Install carpeting using minimum of pieces.
 - .2 Spread full bed of adhesive evenly over substrate surfaces and install floor carpet over adhesive. Roll carpet on horizontal surfaces with approved type roller to remove air pockets, ripples and other defects.
 - .3 Finish installation to present smooth wearing surface free from misalignment, lifting, burring and other faults.
 - .4 Use material from same dye lot. Ensure colour, pattern and texture match within any one visual area. Maintain constant pile direction.
 - .5 Fit neatly around architectural, mechanical, electrical and telephone outlets, and furniture fitments, around perimeter of rooms into recesses, and around projections.
 - .6 Seal edges of cut-outs with latex or use positive binding method.
 - .7 In areas where carpet is laid and underfloor duct and junction boxes occur, cut carpet at boxes to provide a hinged flap over junction boxes. Secure access locations with 'Velcro' strip around three sides of flap, to provide a flush carpet surface.
 - .8 Continue carpeting through passageways and extend carpet into recesses, such as closets, and under movable casework, equipment and other movable items.
 - .9 Join all seams by seaming adhesive method in strict accordance with manufacturer's instructions. Unless otherwise approved by Consultant, cross joints will not be permitted. Maintain run of pile directionally constant.

- .10 Terminate carpeting at centerline of door, in closed position, in openings where adjacent floor finish or colour is dissimilar.
- .11 Install base in accordance with Section 09 65 16.

3.3 CARPET TILE INSTALLATION

- .1 Cut and install carpet to fit tightly and neatly around perimeter of carpeted areas, around permanent fixtures and around projections through the floor.
- .2 Install carpet tile in full bed of adhesive.
- .3 Butt all carpet tiles to tight contact to make all joints as inconspicuous as possible.

3.4 CLEANING AND PROTECTION

- .1 Vacuum carpets clean immediately after completion of installation. Protect traffic areas.
- .2 Prohibit traffic on carpet until adhesive is cured.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 43 00 - Quality Assurance.
- .3 Section 01 74 00 - Cleaning.
- .4 Section 01 74 19 - Waste Management and Disposal.
- .5 Section 01 78 00 - Closeout Submittals.

1.2 DEFINITIONS

- .1 Application Specialist: An individual who performs surface preparation and application of protective coatings and linings to steel and concrete surfaces of complex industrial structures.

1.3 REFERENCE STANDARDS

- .1 Environmental Protection Agency (EPA)
 - .1 Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, EPA Method 24 - Surface Coatings.
 - .2 SW-846, Test Method for Evaluating Solid Waste, Physical/Chemical Methods.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .3 Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.
 - .2 Standard GPS-1, MPI Green Performance Standard.
 - .3 Standard GPS-2, MPI Green Performance Standard.
- .4 National Research Council Canada (NRC)
 - .1 National Fire Code of Canada (NFC).
- .5 Society for Protective Coatings (SSPC)
 - .1 Systems and Specifications, SSPC Painting Manual.
- .6 NACE International
 - .1 ANSI/NACE No. 13/SSPC-ACS-1-SG, Industrial Coating and Lining Application Specialist Qualification and Certification

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Scheduling
 - .1 Provide work schedule for various stages of painting to Consultant for approval. Provide schedule minimum of 48 hours in advance of proposed operations.
 - .2 Obtain written authorization from Consultant for changes in work schedule.
 - .3 Schedule new additions to existing building coordinate painting operations with other trades.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's instructions, printed product literature and data sheets for [paint and paint products] and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS SDS.
 - .3 Confirm products to be used are in MPI's approved product list.
 - .4 Upon completion, provide records of products used. List products in relation to finish system and include the following:
 - .1 Product name, type and use.
 - .2 Manufacturer's product number.
 - .3 Colour numbers.
 - .4 MPI Environmentally Friendly classification system rating.
 - .5 Manufacturer's Safety Data Sheets (SDS).
 - .6 MPI #'s.
- .3 Samples:
 - .1 Provide duplicate 300 x 300 mm sample panels of each paint, stain, clear coating, and special finish with specified paint or coating in colours, gloss/sheen and textures required to MPI Architectural Painting Specification Manual standards submitted on following substrate materials:
 - .1 3 mm plate steel for finishes over metal surfaces.
 - .2 13 mm birch plywood for finishes over wood surfaces.
 - .3 50 mm concrete block for finishes over concrete or concrete masonry surfaces.
 - .4 13 mm gypsum board for finishes over gypsum board and other smooth surfaces.
 - .5 10 mm cedar plywood for finishes over wood surfaces.
 - .2 When approved, samples shall become acceptable standard of quality for appropriate on-site surface with one of each sample retained on-site.
 - .3 Provide full range of available colours where colour availability is restricted.
- .4 Certificates:
 - .1 Submit certifications for Application Specialists to demonstrate compliance to the requirements of ANSI/NACE No.13.

1.6 CLOSEOUT SUBMITTALS

- .1 Provide in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: Provide operation and maintenance data for painting materials for incorporation into manual.
- .3 Include:
 - .1 Product name, type and use.
 - .2 Manufacturer's product number.
 - .3 Colour numbers.
 - .4 MPI Environmentally Friendly classification system rating.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Submit 1 four litre can of each type and colour of primer, stain, and finish coating. Identify colour and paint type in relation to established colour schedule and finish system.

1.8 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Contractor: to have a minimum of 5 years proven satisfactory experience. When requested, provide list of last 3 comparable jobs including, job name and location, specifying authority, and project manager.
 - .2 Qualified journeypersons as defined by local jurisdiction to be engaged in painting work.
 - .3 Apprentices: may be employed provided they work under direct supervision of qualified journeyperson in accordance with trade regulations.
 - .4 Conform to latest MPI requirements for exterior painting work including preparation and priming.
 - .5 Materials: in accordance with MPI Painting Specification Manual "Approved Product" listing and from a single manufacturer for each system used.
 - .6 Retain purchase orders, invoices and documents to prove conformance with noted MPI requirements when requested by Consultant.
 - .7 Standard of Acceptance:
 - .1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.
 - .2 Soffits: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
 - .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.
 - .8 Ensure that 50% of industrial coating specialists persons, who perform concrete and steel surfaces preparation and coating applications, are certified by a recognized Applicator Certification Agency, in accordance with NACE 13 /SSPC ACS-I, Applicator Certification Standard (ACS).
 - .9 Maintain a current and valid ACS certification during project period.
 - .1 Application specialists who perform surface preparation and coating application work on this project must have a current ACS.
 - .10 Notify Consultant of any change in application specialist certification status.
 - .1 Any delays to the completion of the Project due to invalid certifications will not be considered, and liquidated damages shall not be waived for any non-performance by Contractor.
- .2 Mock-Ups:
 - .1 When requested by Consultant or Paint Inspection Agency, prepare and paint designated surface, area, room or item to requirements specified herein, with specified paint or coating showing selected colours, number of coats, gloss/sheen, textures and quality of work to MPI Painting Specification Manual standards for review and approval.
 - .2 Construct mock-ups in accordance with Section 01 43 00 - Quality Assurance.
 - .1 Submit 600 mm x 600 mm mock-up. Prepare and paint designated surface, area, room or item (in each colour scheme) to specified requirements, with specified paint or coating showing selected colours, gloss/sheen, textures.

- .2 Mock-up will be used:
 - .1 To judge quality of work, substrate preparation, operation of equipment and material application and skill to MPI Architectural Painting Specification Manual standards.
- .3 Locate where directed.
- .4 Allow 24 hours for inspection of mock-up before proceeding with Work.
- .5 When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.

1.9 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 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.
 - .1 Labels: to indicate:
 - .1 Type of paint or coating.
 - .2 Compliance with applicable standard.
 - .3 Colour number in accordance with established colour schedule.
- .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 Observe manufacturer's recommendations for storage and handling.
 - .3 Store materials and supplies away from heat generating devices.
 - .4 Store materials and equipment in well-ventilated area with temperature range 7 degrees C to 30 degrees C.
 - .5 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Consultant. After completion of operations, return areas to clean condition to approval of Consultant.
 - .6 Remove paint materials from storage only in quantities required for same day use.
 - .7 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.
 - .8 Fire Safety Requirements:
 - .1 Provide 9 kg dry chemical fire extinguisher adjacent to storage area.
 - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
 - .3 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada (NFC).
 - .9 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

1.10 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Heating, Ventilation and Lighting:

- .1 Do not perform painting work unless adequate and continuous ventilation and sufficient heating facilities are in place to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application until paint has cured sufficiently.
- .2 Where required, provide continuous ventilation for seven days after completion of application of paint.
- .3 Coordinate use of existing ventilation system with Owner and General Contractor Consultant and ensure its operation during and after application of paint as required.
- .4 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
- .5 Perform no painting work unless a minimum lighting level of 323 Lux is provided on surfaces to be painted. Adequate lighting facilities to be provided by General Contractor.
- .2 Temperature, Humidity and Substrate Moisture Content Levels:
 - .1 Unless specifically pre-approved by specifying body, Paint Inspection Agency and, applied product manufacturer, perform no painting work when:
 - .1 Ambient air and substrate temperatures are below 10 degrees C.
 - .2 Substrate temperature is over 32 degrees C unless paint is specifically formulated for application at high temperatures.
 - .3 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's prescribed limits.
 - .4 Relative humidity is above 85% or when dew point is less than 3 degrees C variance between air/surface temperature.
 - .5 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.
 - .2 Perform no painting work when maximum moisture content of substrate exceeds:
 - .1 12% for concrete and masonry (clay and concrete brick/block).
 - .2 15% for hard wood.
 - .3 17% for soft wood.
 - .4 12% for plaster and gypsum board.
 - .3 Conduct moisture tests using a properly calibrated electronic Moisture Meter, except test concrete floors for moisture using a simple "cover patch test".
 - .4 Test concrete, masonry and plaster surfaces for alkalinity as required.
- .3 Application Requirements:
 - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
 - .2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits noted herein.
 - .3 Apply paint when previous coat of paint is dry or adequately cured.
 - .4 Apply paint finishes when conditions forecast for entire period of application fall within manufacturer's recommendations.
 - .5 Do not apply paint when:
 - .1 Temperature is expected to drop below 10 degrees C before paint has thoroughly cured.
 - .2 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's limits.

- .3 Surface to be painted is wet, damp or frosted.
- .6 Provide and maintain cover when paint must be applied in damp or cold weather. Heat substrates and surrounding air to comply with temperature and humidity conditions specified by manufacturer. Protect until paint is dry or until weather conditions are suitable.
- .7 Schedule painting operations such that surfaces exposed to direct, intense sunlight are scheduled for completion during early morning.
- .8 Remove paint from areas which have been exposed to freezing, excess humidity, rain, snow or condensation. Prepare surface again and repaint.
- .9 Paint occupied facilities in accordance with approved schedule only. Schedule operations to approval of Consultant and Owner such that painted surfaces will have dried and cured sufficiently before occupants are affected.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- .1 Environmental Performance Requirements:
 - .1 Provide paint products meeting MPI "Environmentally Friendly" E3 ratings based on VOC (EPA Method 24) content levels.
 - .2 Green Performance in accordance with MPI Standard GPS-2.

2.2 MATERIALS

- .1 Only paint materials listed in latest edition of MPI Approved Products List (APL) are acceptable for use on this project.
- .2 Paint materials for paint systems: to be products of single manufacturer.
- .3 Only qualified products with E3 "Environmentally Friendly" ratings are acceptable for use on this project.
- .4 Use only MPI listed L rated materials.
- .5 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids, to be as follows:
 - .1 Be water-based.
 - .2 Be non-flammable.
 - .3 Be manufactured without compounds which contribute to ozone depletion in upper atmosphere.
 - .4 Be manufactured without compounds which contribute to smog in the lower atmosphere.
 - .5 Do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.
- .6 Water-borne surface coatings must be manufactured and transported in a manner that steps of processes, including disposal of waste products arising there from, will meet requirements of applicable governmental acts, by-laws and regulations including, for facilities located in Canada, Fisheries Act and Canadian Environmental Protection Act (CEPA).
- .7 Water-borne surface coatings must not be formulated or manufactured with aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

- .8 Water-borne surface coatings and recycled water-borne surface coatings must have flash point of 61.0 degrees C or greater.
- .9 Both water-borne surface coatings and recycled water-borne surface coatings must be made by a process that does not release:
 - .1 Matter in undiluted production plant effluent generating a 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to a natural watercourse or a sewage treatment facility lacking secondary treatment.
 - .2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to a natural watercourse or a sewage treatment facility lacking secondary treatment.
- .10 Water-borne paints and stains, recycled water-borne surface coatings and water borne varnishes must meet a minimum "Environmentally Friendly" E2 rating.
- .11 Recycled water-borne surface coatings must contain 50% post-consumer material by volume.
- .12 Recycled water-borne surface coatings must not contain:
 - .1 Lead in excess of 600.0 ppm weight/weight total solids.
 - .2 Mercury in excess of 50.0 ppm weight/weight total product.
 - .3 Cadmium in excess of 1.0 ppm weight/weight total product.
 - .4 Hexavalent chromium in excess of 3.0 ppm weight/weight total product.
 - .5 Organochlorines or polychlorinated biphenyls (PCBS) in excess of 1.0 ppm weight/weight total product.
- .13 The following must be performed on each batch of consolidated post-consumer material before surface coating is reformulated and canned. These tests must be performed at a laboratory or facility which has been accredited by the Standards Council of Canada.
 - .1 Lead, cadmium and chromium are to be determined using ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectroscopy) technique no. 6010 as defined in EPA SW-846.
 - .2 Mercury is to be determined by Cold Vapour Atomic Absorption Spectroscopy using Technique no. 7471 as defined in EPA SW-846.
 - .3 Organochlorines and PCBs are to be determined by Gas Chromatography using Technique no. 8081 as defined in EPA SW-846.

2.3 COLOURS

- .1 Selection of colours will be from manufacturers' full range of colours.
- .2 Where specific products are available in restricted range of colours, selection will be based on limited range.
- .3 Second coat in three coat system to be tinted slightly lighter colour than topcoat to show visible difference between coats if requested by Consultant.
- .4 For deep and ultra deep colours 4 coats may be required.

2.4 MIXING AND TINTING

- .1 Perform colour tinting operations prior to delivery of paint to site. On-site tinting of painting materials is allowed only with Consultant's written permission.
- .2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written

instructions.

- .3 Add thinner to paint manufacturer's recommendations. Do not use kerosene or organic solvents to thin water-based paints.
- .4 Thin paint for spraying according in accordance with paint manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to, Consultant.
- .5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.
- .6 Deep and ultra deep colors; 4 coats may be required.

2.5 GLOSS/SHEEN RATINGS

- .1 Paint gloss: defined as sheen rating of applied paint, in accordance with following values:

Gloss Level Category	Units @ 60 Degrees	Units @ 85 Degrees
G1 - matte finish	0 to 5	max. 10
G2 - velvet finish	0 to 10	10 to 35
G3 - eggshell finish	10 to 25	10 to 35
G4 - satin finish	20 to 35	min. 35
G5 - semi-gloss finish	35 to 70	
G6 - gloss finish	70 to 85	
G7 - high gloss finish	> 85	

- .2 Gloss level ratings of painted surfaces as specified and as noted on Finish Schedule.

2.6 EXTERIOR PAINTING SYSTEMS

- .1 Asphalt Surfaces: one/traffic marking for drive and parking areas, etc.
 - .1 EXT 2.1A - Latex zone/traffic marking finish.
- .2 Concrete Vertical Surfaces: (including horizontal soffits).
 - .1 EXT 3.1A - Latex G5 (over alkali-resistant primer) finish.
- .3 Concrete Horizontal Surfaces: decks.
 - .1 EXT 3.2A - Latex floor paint low gloss finish.
- .4 Concrete Masonry Units: smooth and split face block and brick
 - .1 EXT 4.2A - Latex G4 (over latex block filler) finish.
- .5 Structural Steel and Metal Fabrications:
 - .1 EXT 5.1A - Quick dry enamel semi-gloss (over q.d. primer) finish.
- .6 Galvanized Metal: not chromate passivated.
 - .1 EXT 5.3A - Latex G5 (over cementitious primer) finish.
- .7 Wood Decks and Stairs/Steps and handrails/guards: using spaced lumber.
 - .1 EXT 6.5A - Latex porch and floor low gloss finish (over alkyd/oil primer). Shrinkage-reducing admixture (SRA) optional.

PART 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 GENERAL

- .1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.3 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable to be painted in accordance with manufacturer's written instructions:
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.
- .2 Exterior repainting work: inspected by MPI Accredited Paint Inspection Agency (inspector) acceptable to specifying authority and local Painting Contractor's Association. Painting contractor to notify Paint Inspection Agency minimum of one week prior to commencement of work and provide copy of project repainting specification and Finish Schedule.
- .3 Exterior surfaces requiring repainting: inspected by both painting contractor and Paint Inspection Agency who will notify Consultant in writing of defects or problems, prior to commencing repainting work, or after surface preparation if unseen substrate damage is discovered.
- .4 Where assessed degree of surface degradation of DSD-1 to DSD-3 before preparation of surfaces for repainting is revealed to be DSD-4 after preparation, repair or replacement of such unforeseen defects discovered are to be corrected, as mutually agreed, before repainting is started.
- .5 Where "special" repainting or recoating system applications (i.e. elastomeric coatings) or non- MPI listed products or systems are to be used, paint or coating manufacturer to provide as part of work, certification of surfaces and conditions for specific paint or coating system application as well as on site supervision, inspection and approval of their paint or coating system application as required at no additional cost to Consultant.

3.4 PREPARATION

- .1 Perform preparation and operations for exterior painting in accordance with MPI Maintenance Repainting Manual except where specified otherwise.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.
- .3 Clean and prepare exterior surfaces to be repainted in accordance with MPI Maintenance Repainting Manual requirements. Refer to the MPI Manual regarding specific requirements and

as follows:

- .1 Remove dust, dirt, and surface debris by vacuuming, wiping with dry, clean cloth or compressed air.
 - .2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Allow surfaces to drain completely and allow to dry thoroughly. Allow sufficient drying time and test surfaces using electronic moisture meter before commencing work.
 - .5 Use water-based cleaners in place of organic solvents where surfaces will be repainted using water-based paints.
 - .6 Many water-based paints cannot be removed with water once dried. Minimize use of kerosene or such organic solvents to clean up water-based paints.
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- .4 Clean metal surfaces to be repainted by removing rust, dirt, oil, grease and foreign substances in accordance with MPI requirements. Remove such contaminants from surfaces, pockets and corners to be repainted by brushing with clean brushes, blowing with clean dry compressed air, or brushing/vacuum cleaning as required.
 - .5 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before priming and between applications of remaining coats. Touch-up, spot prime, and apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.
 - .6 Do not apply paint until prepared surfaces have been accepted by Consultant.
 - .7 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.

3.5 EXISTING CONDITIONS

- .1 Conduct moisture testing of surfaces to be painted using a properly calibrated electronic moisture meter, except test concrete floors for moisture using a simple "cover patch test" and report findings to Consultant. Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.
- .2 Maximum moisture content as follows:
 - .1 Stucco: 12%.
 - .2 Concrete: 12%.
 - .3 Clay and Concrete Block/Brick: 12%.
 - .4 Hard Wood: 15%.
 - .5 Soft Wood: 17%

3.6 PROTECTION

- .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore such surfaces as directed by Consultant.
- .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
- .3 Protect factory finished products and equipment.

- .4 Protect passing pedestrians, building occupants and general public in and about building.
- .5 Remove light fixtures, surface hardware on doors, and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Store items and re-install after painting is completed.
- .6 Move and cover exterior furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
- .7 As painting operations progress, place "WET PAINT" signs in pedestrian and vehicle traffic areas to approval of Consultant.

3.7 APPLICATION

- .1 Method of application to be as approved by Consultant. Apply paint by brush, roller, air sprayer, or airless sprayer as required. Conform to manufacturer's application instructions unless specified otherwise.
- .2 Brush and Roller Application:
 - .1 Apply paint in a uniform layer using brush and/or roller of types suitable for application.
 - .2 Work paint into cracks, crevices and corners.
 - .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
 - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces to be free of roller tracking and heavy stipple unless approved by Consultant.
 - .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Spray Application:
 - .1 Provide and maintain equipment that is suitable for intended purpose, capable of properly atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - .2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
 - .3 Apply paint in a uniform layer, with overlapping at edges of spray pattern.
 - .4 Brush out immediately runs and sags.
 - .5 Use brushes to work paint into cracks, crevices and places which are not adequately painted by spray.
 - .6 Wood, stucco, concrete, cement masonry units CMU's and brick; if sprayed, must be back rolled.
- .4 Use dipping, sheepskins or daubers when no other method is practical in places of difficult access and when specifically authorized by Consultant.
- .5 Apply coats of paint as continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- .6 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .7 Sand and dust between coats to remove visible defects.
- .8 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including

such surfaces as projecting ledges.

- .9 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.8 SITE QUALITY CONTROL

- .1 Exterior painting and decorating work to be inspected by MPI Accredited Paint Inspection Agency (inspector) acceptable to specifying authority and local Painting Contractor's Association. Painting contractor will notify Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of project painting specification, plans and elevation drawings (including pertinent details) as well as Finish Schedule.
- .2 Exterior surfaces requiring painting to be inspected by Paint Inspection Agency who will notify Consultant and General Contractor in writing of defects or problems, prior to commencing painting work, or after prime coat shows defects in substrate.
- .3 Where "special" painting, coating or decorating system applications (i.e. elastomeric coatings) or non- MPI listed products or systems are to be used, paint or coating manufacturer to provide as part of this work, certification of surfaces and conditions for specific paint or coating system application as well as on site supervision, inspection and approval of their paint or coating system application as required at no additional cost to Consultant.
- .4 Standard of Acceptance:
- .1 Walls: no defects visible from distance of 1000 mm at 90 degrees to surface.
- .2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
- .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.
- .5 Field inspection of painting operations to be carried out by independent inspection firm as designated by Consultant.
- .6 Advise Consultant when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.
- .7 Cooperate with inspection firm and provide access to areas of work.
- .8 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Consultant.

3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning:
- .1 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 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.10 RESTORATION

- .1 Clean and re-install hardware items removed before undertaken painting operations.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.
- .3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to approval of Consultant. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Consultant.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 43 00 - Quality Assurance.
- .3 Section 01 74 19 - Waste Management and Disposal.
- .4 Section 01 78 00 - Closeout Submittals.

1.2 REFERENCE STANDARDS

- .1 Environmental Protection Agency (EPA)
 - .1 Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, EPA Method 24 - Surface Coatings.
 - .2 SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .3 Master Painters Institute (MPI)
 - .1 The Master Painters Institute (MPI)/Architectural Painting Specification Manual (ASM) - current edition.
 - .2 Standard GPS-1, MPI Green Performance Standard.
 - .3 Standard GPS-2, MPI Green Performance Standard.
- .4 National Research Council Canada (NRC)
 - .1 National Fire Code of Canada (NFC).
- .5 Society for Protective Coatings (SSPC)
 - .1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Scheduling:
 - .1 Submit work schedule for various stages of painting to Consultant for review. Provide schedule minimum of 48 hours in advance of proposed operations.
 - .2 Obtain written authorization from Consultant for changes in work schedule.
 - .3 Schedule new additions to existing building coordinate painting operations with other trades.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's instructions, printed product literature and data sheets for paint and paint products and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS SDS.

- .3 Confirm products to be used are in MPI's approved product list.
- .3 Upon completion, provide records of products used. List products in relation to finish system and include the following:
 - .1 Product name, type and use.
 - .2 Manufacturer's product number.
 - .3 Colour numbers.
 - .4 Manufacturer's Safety Data Sheets (SDS).
 - .5 MPI #'s.
- .4 Samples:
 - .1 Submit full range colour sample chips to indicate where colour availability is restricted.
 - .2 Submit duplicate 300 x 300 mm sample panels of each paint, stain, clear coating and special finish with specified paint or coating in colours, gloss/sheen and textures required to MPI Architectural Painting Specification Manual standards submitted on following substrate materials:
 - .1 3 mm plate steel for finishes over metal surfaces.
 - .2 13 mm plywood for finishes over wood surfaces.
 - .3 50 mm concrete block for finishes over concrete or concrete masonry surfaces.
 - .4 13 mm gypsum board for finishes over gypsum board and other smooth surfaces.
 - .5 10 mm cedar plywood for finishes over wood surfaces.
 - .3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.
- .5 Test reports: Provide certified test reports for paint from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .1 Lead, cadmium and chromium: presence of and amounts.
 - .2 Mercury: presence of and amounts.
 - .3 Organochlorines and PCBs: presence of and amounts.
- .6 Certificates: Provide certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties. MPI Gateway #.
- .7 Manufacturer's Instructions:
 - .1 Provide manufacturer's installation and application instructions.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: Provide operation and maintenance data for painting materials for incorporation into manual.
- .3 Include:
 - .1 Product name, type and use.
 - .2 Manufacturer's product number.
 - .3 Colour numbers.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Submit 1 two litre can of each type and colour of primer, stain and finish coating. Identify colour and paint type in relation to established colour schedule and finish system.

1.7 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Contractor: to have a minimum of 5 years proven satisfactory experience. When requested, provide list of last 3 comparable jobs including, job name and location, specifying authority, and project manager.
 - .2 Qualified journeypersons as defined by local jurisdiction to be engaged in painting work.
 - .3 Apprentices: may be employed provided they work under direct supervision of qualified journeyperson in accordance with trade regulations.
 - .4 Conform to latest MPI requirements for exterior painting work including preparation and priming.
 - .5 Materials: in accordance with MPI Painting Specification Manual "Approved Product" listing and from a single manufacturer for each system used.
 - .6 Retain purchase orders, invoices and documents to prove conformance with noted MPI requirements when requested by Consultant.
 - .7 Standard of Acceptance:
 - .1 Walls: no defects visible from 1000 mm at 90 degrees to surface.
 - .2 Soffits: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
 - .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.
- .2 Mock-Ups:
 - .1 When requested by Consultant or Paint Inspection Agency, prepare and paint designated surface, area, room or item to requirements specified herein, with specified paint or coating showing selected colours, number of coats, gloss/sheen, textures and quality of work to MPI Painting Specification Manual standards for review and approval.
 - .2 Construct mock-ups in accordance with Section 01 43 00 - Quality Assurance.
 - .1 Provide 600 mm x 600 mm mock-up. Prepare and paint designated surface, area, room or item (in each colour scheme) to specified requirements, with specified paint or coating showing selected colours, gloss/sheen, textures.
 - .2 Mock-up will be used:
 - .1 To judge quality of work, substrate preparation, operation of equipment and material application and skill to MPI Architectural Painting Specification Manual standards.
 - .3 Locate where directed or where indicated.
 - .4 Allow 24 hours for inspection of mock-up before proceeding with Work.
 - .5 When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
 - .1 Labels: to indicate:
 - .1 Type of paint or coating.
 - .2 Compliance with applicable standard.
 - .3 Colour number in accordance with established colour schedule.
- .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 Observe manufacturer's recommendations for storage and handling.
 - .3 Store materials and supplies away from heat generating devices.
 - .4 Store materials and equipment in well-ventilated area with temperature range 7 degrees C to 30 degrees C.
 - .5 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Consultant. After completion of operations, return areas to clean condition to approval of Consultant.
 - .6 Remove paint materials from storage only in quantities required for same day use.
 - .7 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.
 - .8 Fire Safety Requirements:
 - .1 Provide one 9 kg dry chemical fire extinguisher adjacent to storage area.
 - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
 - .3 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada (NFC).
- .4 Packaging Waste Management: remove for recycling and reuse of pallets, crates, padding, and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

1.9 SITE CONDITIONS

- .1 Ambient Conditions:
 - .1 Heating, Ventilation and Lighting:
 - .1 Provide heating facilities to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application until paint has cured sufficiently.
 - .2 Provide continuous ventilation for 7 days after completion of application of paint.
 - .3 Coordinate use of existing ventilation system with Consultant and ensure its operation during and after application of paint as required.
 - .4 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
 - .5 Provide minimum lighting level of 323 Lux on surfaces to be painted.
 - .6 Temperature, Humidity and Substrate Moisture Content Levels:

- .1 Unless pre-approved written approval by Specifying body and product manufacturer, perform no painting when:
 - .1 Ambient air and substrate temperatures are below 10 degrees C.
 - .2 Substrate temperature is above 32 degrees C unless paint is specifically formulated for application at high temperatures.
 - .3 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.
 - .4 The relative humidity is under 85% or when the dew point is more than 3 degrees C variance between the air/surface temperature. Paint should not be applied if the dew point is less than 3 degrees C below the ambient or surface temperature. Use sling psychrometer to establish the relative humidity before beginning paint work.
 - .5 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.
 - .6 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.
- .2 Perform painting work when maximum moisture content of the substrate is below:
 - .1 12% for concrete and masonry (clay and concrete brick/block). Allow new concrete and masonry to cure minimum of 28 days.
 - .2 15% for hard wood.
 - .3 17% for soft wood.
 - .4 12% for plaster and gypsum board.
- .3 Test for moisture using calibrated electronic Moisture Meter. Test concrete floors for moisture using "cover patch test".
- .4 Test concrete, masonry and plaster surfaces for alkalinity as required.
- .7 Surface and Environmental Conditions:
 - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
 - .2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.
 - .3 Apply paint when previous coat of paint is dry or adequately cured.
- .8 Additional interior application requirements:
 - .1 Apply paint finishes when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.
 - .2 Apply paint in occupied facilities during silent hours only. Schedule operations to approval of Consultant such that painted surfaces will have dried and cured sufficiently before occupants are affected.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- .1 Environmental Performance Requirements:
 - .1 Provide paint products meeting MPI "Environmentally Friendly" E3 ratings based on

- VOC (EPA Method 24) content levels.
- .2 Green Performance in accordance with MPI Standard GPS-2.

2.2 MATERIALS

- .1 Only Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.
- .2 Provide paint materials for paint systems from single manufacturer.
- .3 Only qualified products with E3 "Environmentally Friendly" rating are acceptable for use on this project.
- .4 Conform to latest MPI requirements for interior painting work including preparation and priming.
- .5 Provide paint products meeting MPI "Environmentally Friendly" E3 ratings based on VOC (EPA Method 24) content levels.
- .6 Use MPI listed materials having minimum E3 rating where indoor air quality (odour) requirements exist.
- .7 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids to be:
 - .1 Be Water-based.
 - .2 Be non-flammable.
 - .3 Be manufactured without compounds which contribute to ozone depletion in the upper atmosphere.
 - .4 Be manufactured without compounds which contribute to smog in the lower atmosphere.
 - .5 Do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.
- .8 Ensure manufacture and process of both water-borne surface coatings and recycled water-borne surface coatings does not release:
 - .1 Matter in undiluted production plant effluent generating 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment.
 - .2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to natural watercourse or a sewage treatment facility lacking secondary treatment.
- .9 Water-borne paints and stains, recycled water-borne surface coatings and water borne varnishes to meet minimum "Environmentally Friendly" E2 rating.
- .10 Recycled water-borne surface coatings to contain 50% post-consumer material by volume.

2.3 COLOURS

- .1 Selection of colours will be from manufacturers full range of colours.
- .2 Where specific products are available in restricted range of colours, selection based on limited range.
- .3 Second coat in three coat system to be tinted slightly lighter colour than topcoat to show visible difference between coats, if requested by Consultant.

- .4 For deep and ultra deep colours; 4 coats may be required.

2.4 MIXING AND TINTING

- .1 Perform colour tinting operations prior to delivery of paint to site. Obtain written approval from Consultant for tinting of painting materials.
- .2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.
- .3 Use and add thinner in accordance with paint manufacturer's recommendations. Do not use kerosene or similar organic solvents to thin water-based paints.
- .4 Thin paint for spraying in accordance with paint manufacturer's instructions.
- .5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity. Strain as necessary.

2.5 GLOSS/SHEEN RATINGS

- .1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:
- | Gloss | @ 60 degrees | Sheen @ 85 degrees |
|--|--------------|--------------------|
| Gloss Level 1 - Matte Finish (flat) | Max. 5 | Max. 10 |
| Gloss Level 2 - Velvet-Like Finish | Max. 10 | 10 to 35 |
| Gloss Level 3 - Eggshell Finish | 10 to 25 | 10 to 35 |
| Gloss Level 4 - Satin-Like Finish | 20 to 35 | min. 35 |
| Gloss Level 5 - Traditional Semi-Gloss | 35 to 70 | |
| Finish Gloss Level 6 - Traditional Gloss | 70 to 85 | |
| Gloss Level 7 - High Gloss Finish | More than 85 | |
- .2 Gloss level ratings of painted surfaces as indicated and as noted on Finish Schedule.

2.6 INTERIOR PAINTING SYSTEMS

- .1 Concrete vertical surfaces: including horizontal soffits:
- .1 INT 3. 1A - Latex G5 finish (over alkali-resistant primer).
- .2 Concrete masonry units: smooth block:
- .1 INT 4.2A - Latex G5 (over latex block filler) finish.
- .3 Structural steel and metal fabrications: columns, beams, joists:
- .1 INT 5.1A - Quick dry enamel gloss (over Q.D. alkyd primer) finish.
- .4 Galvanized metal: doors, frames, railings, misc. steel, pipes, overhead decking, and ducts.
- .1 INT 5.3A - Latex G5 finish.
- .5 Wood paneling and casework: partitions, panels, shelving, millwork:
- .1 INT 6.4A - Latex G2 finish (over alkyd primer/sealer).
- .6 Plaster and gypsum board: gypsum wallboard, drywall, "sheet rock type material", and textured finishes:
- .1 INT 9.2A - Latex G1 finish (over latex primer/sealer).

PART 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 data sheet.

3.2 GENERAL

- .1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.3 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable to be painted in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.
- .2 Interior repainting work: inspected by MPI Accredited Paint Inspection Agency (inspector) acceptable to specifying authority and local Painting Contractor's Association. Painting contractor to notify Paint Inspection Agency minimum of one week prior to commencement of work and provide copy of project repainting specification and Finish Schedule .
- .3 Interior surfaces requiring repainting: inspected by both painting contractor and Paint Inspection Agency who will notify Consultant in writing of defects or problems, prior to commencing repainting work, or after surface preparation if unseen substrate damage is discovered.
- .4 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.
- .5 Maximum moisture content as follows:
 - .1 Stucco, plaster and gypsum board: 12%.
 - .2 Concrete: 12%.
 - .3 Clay and Concrete Block/Brick: 12%.
 - .4 Hard Wood: 15%.
 - .5 Soft Wood: 17%.

3.4 PREPARATION

- .1 Protection (not applicable to new painting work):
 - .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by Consultant.
 - .2 Protect items that are permanently attached such as Fire Labels on doors and frames.

- .3 Protect factory finished products and equipment.
- .4 Protect passing pedestrians, building occupants and general public in and about the building.
- .2 Surface Preparation (not applicable to new painting work):
 - .1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.
 - .2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
 - .3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of Consultant.
- .3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
 - .1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths or compressed air.
 - .2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Allow surfaces to drain completely and allow to dry thoroughly.
 - .5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
 - .6 Use trigger operated spray nozzles for water hoses.
 - .7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water-based paints.
- .5 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.
- .6 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.
 - .1 Apply sealer to MPI #36 over knots, pitch, sap and resinous areas
 - .2 Apply wood filler to nail holes and cracks.
 - .3 Tint filler to match stains for stained woodwork.
- .7 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.
- .8 Carried out during shop priming: clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes, blowing with clean dry compressed air or vacuum cleaning.
- .9 Touch up of shop primers with primer as specified.
- .10 Do not apply paint until prepared surfaces have been accepted by Consultant.

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3.5 EXISTING CONDITIONS

- .1 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test" and report findings to Consultant. Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.
- .2 Maximum moisture content as follows:
 - .1 Stucco: 12%.
 - .2 Concrete: 12%.
 - .3 Clay and Concrete Block/Brick: 12%.
 - .4 Hard Wood: 15%.
 - .5 Soft Wood: 17%.

3.6 APPLICATION

- .1 Method of application to be as approved by Consultant. Apply paint by brush, roller, air sprayer or airless sprayer as required. Conform to manufacturer's application instructions unless specified otherwise.
- .2 Brush and Roller Application:
 - .1 Apply paint in uniform layer using brush and/or roller type suitable for application.
 - .2 Work paint into cracks, crevices and corners.
 - .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
 - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.
 - .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Spray application:
 - .1 Provide and maintain equipment that is suitable for intended purpose, capable of atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - .2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
 - .3 Apply paint in uniform layer, with overlapping at edges of spray pattern. Back roll first coat application.
 - .4 Brush out immediately all runs and sags.
 - .5 Use brushes and rollers to work paint into cracks, crevices and places which are not adequately painted by spray.
- .4 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access.
- .5 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- .6 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .7 Sand and dust between coats to remove visible defects.

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- .8 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
- .9 Finish inside of cupboards and cabinets as specified for outside surfaces.
- .10 Finish closets and alcoves as specified for adjoining rooms.
- .11 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.
- .12 Wood, drywall, plaster, stucco, concrete, concrete masonry units and brick; if sprayed, must be back rolled.

3.7 SITE TOLERANCES

- .1 Walls: no defects visible from distance of 1000 mm at 90 degrees to surface.
- .2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
- .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

3.8 SITE QUALITY CONTROL

- .1 Interior painting and decorating work to be inspected by a MPI Accredited Paint Inspection Agency (inspector) acceptable to specifying authority and local Painting Contractor's Association. Painting contractor will notify Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of project painting specification, plans and elevation drawings (including pertinent details) as well as a Finish Schedule.
- .2 Interior surfaces requiring painting to be inspected by Paint Inspection Agency who will notify Consultant and General Contractor in writing of defects or problems, prior to commencing painting work, or after prime coat shows defects in substrate.
- .3 Where "special" painting, coating or decorating system applications (i.e. elastomeric coatings) or non- MPI listed products or systems are to be used, paint or coating manufacturer will provide as part of this work, certification of surfaces and conditions for specific paint or coating system application as well as on site supervision, inspection and approval of their paint or coating system application as required at no additional cost to Consultant.
- .4 Standard of Acceptance:
 - .1 Walls: no defects visible from distance of 1000 mm at 90 degrees to surface.
 - .2 Ceilings: no defects visible from floor at 45 degrees degrees to surface when viewed using final lighting source.
 - .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.
- .5 Field inspection of painting operations to be carried out by independent inspection firm as designated by Consultant.
- .6 Advise Consultant when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.

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- .7 Cooperate with inspection firm and provide access to areas of work.
- .8 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Consultant.

3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 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 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.10 RESTORATION

- .1 Clean and re-install hardware items removed before undertaken painting operations.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.
- .3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to approval of Consultant. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Consultant.

END OF SECTION

Part-1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 06 20 00 - Finish Carpentry

1.2 REFERENCE STANDARDS

- .1 Aluminum Association (AA)
 - .1 DAF 45-03, Designation System for Aluminum Finishes.
- .2 American National Standards Institute (ANSI)
 - .1 ANSI A135.4-2004, Hardboard Standard.
 - .2 ANSI A208.1-2009, Particleboard.
 - .3 ANSI A208.2-2009, Medium Density Fiberboard for Interior Use.
- .4 Canadian General Standards Board (CGSB)
 - .1 CGSB 41-GP-30M-82, Wall coverings, Vinyl-Coated Fabrics.
- .5 CSA Group (CSA)
 - .1 CSA O121-08, Douglas Fir Plywood.
 - .2 CSA O151-09, Canadian Softwood Plywood.
 - .3 CAN/CSA-Z809-08, Sustainable Forest Management.
- .6 Environmental Choice Program (ECP)
 - .1 CCD-046-95, Adhesives.
- .7 Forest Stewardship Council (FSC)
 - .1 FSC-STD-01-001-2004, FSC Principle and Criteria for Forest Stewardship.
- .8 Green Seal Environmental Standards (GS)
 - .1 GS-11-11, Standard for Paints and Coatings.
 - .2 GS-36-11, Standard for Adhesives for Commercial Use.
- .9 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2011, Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.
- .10 Sustainable Forestry Initiative (SFI)
 - .1 SFI-2010-2014 Standard.
- .11 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-2010, Standard Method of Test for Surfaces Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S706-09, Standard for Wood Fibre Insulating Boards for Buildings.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirement.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for tackboards and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Installation Drawings:
 - .1 Submit installation drawings.
 - .2 Indicate location, type, size, panel arrangement, backing, hardware, anchor or mounting details, frame or trim and accessories.
- .4 Samples:
 - .1 Submit duplicate 300 x 300 mm sample of each type of tackboard and 300 mm long sample of each type of trim.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements:
 - .1 Surface burning characteristics of materials: listed and labelled by an organization accredited by Standards Council of Canada.
- .2 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .3 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 00 - General Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect tackboards from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in accordance with Section 01 00 10 - General.

Part-2 PRODUCTS

2.1 MATERIALS

- .1 Utility sheet aluminum: plain, 3 mm minimum thickness.

- .2 Laminating adhesive: [to manufacturer's standard].
- .3 Mounting adhesive: [to manufacturer's standard].
- .4 Joint reinforcement: concealed mechanical jointing system to provide straight, rigid, continuously supported, tight butt, flush joints at surface.
- .5 Anchor clips, brackets and fasteners: concealed type recommended by manufacturer or Consultant for fixed, interchangeable or vertical adjustment mounting.
- .6 Facings:
 - .1 Natural cork tackboards: single layer natural cork fine grain sheet, 6 mm thick, natural colour selected by Consultant, listed and labelled.
 - .1 Surface burning characteristics in accordance with CAN/ULC-S102.
 - .2 Composition cork tackboards: resilient smooth surface, uniform density composition cork with an anti-soil, washable surface finish which is resistant to fading under artificial or natural light, colour selected by Consultant.
 - .1 Listed and labelled.
 - .2 Surface burning characteristics in accordance with CAN/ULC-S102, flame.
 - .3 Plastic sealed tackboard: plastic sealed cork with burlap back, 6 mm thick, colour selected by Consultant.
 - .4 Vinyl fabric: to CGSB 41-GP-30M, listed and labelled, weave pattern, colour selected by Consultant.
 - .1 Surface burning characteristics in accordance with CAN/ULC-S102, flame spread.
 - .5 Fabric: burlap, colour selected by Consultant.
- .7 Core:
 - .1 Fibreboard: to CAN/ULC-S706, Type II.
 - .2 Particle board: to ANSI A208.1, Grade[R].
 - .3 Plywood: to CSA O121, CSA O151.
 - .4 Hardboard: to ANSI A135.4.
 - .5 Medium Density Fibreboard (MDF): to [ANSI A208.2].
 - .6 CAN/CSA-Z809 or FSC or SFI certified
 - .7 Urea-formaldehyde free.
- .8 Backing:
 - .1 2 mm aluminum sheet for sliding or hinged panels.
 - .2 vinyl, plastic film.

2.2 COMPONENTS

- .1 Extruded aluminum: aluminum Association alloy AA6063-T5. Minimum 1.5 mm wall thickness.
- .2 Extruded vinyl: rigid PVC, integral colour selected by Consultant, 1.5 mm minimum wall thickness.

- .3 Wood: stain, to requirements of Section 06 20 00 - Finish Carpentry.
- .4 Tackboard trim and framing: perimeter trim or frame with coloured vinyl insert, with cork or coloured vinyl insert, bottom rail with integral chalk trough end closures, of manufacturer's standard sections appropriate for installation conditions.

2.4 ACCESSORIES

- .1 Manufacturer's standard.

2.5 FABRICATION

- .1 Fabricate tackboard panels to sizes indicated.
- .2 Factory laminate tackboards, consisting of facing sheet, with core, and backing sheet.
- .3 Wrap around edges and fasten to back face.
- .4 Make finished panels flat and rigid [and fit with joint reinforcement].
- .5 Install trim on panels in factory.
 - .1 Make mitres and joints to hair-line fit, free of rough edges with concealed brackets to reinforce and hold joints tight and flush.
 - .2 No exposed fasteners permitted.
- .6 Overlap trim 6 mm onto panels.
 - .1 Include closed ends for chalktroughs and open-end extrusions.
- .7 Factory fit assemblies too large for shipment to site in one piece, disassemble for delivery and site assembly.

2.6 FINISHES

- .1 Aluminum trim finishes:
 - .1 Finish exposed surfaces of aluminum components in accordance with Aluminum Association Designation System for Aluminum Finishes.
 - .1 Integral colour anodic finish: colour to match Consultant's sample.
 - .2 Appearance and properties of anodized finishes designated by the Aluminum Association as Architectural Class 1, Architectural Class 2, and Protective and Decorative.
- .2 Wood trim finishes:
 - .1 Finish for wood components: Clear, satin finish.

Part-3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for tackboard installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.

- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.3 INSTALLATION

- .1 Install tackboards in accordance with manufacturer's instructions, parallel to floor with uniform vertical surface, plumb and level, to provide rigid, secure surface.
- .2 Install trim and framing around tackboard panels. Make mitres and joints to hair-line fit, free of rough edges.
- .3 Use concealed brackets to reinforce and hold joints tight and flush.
- .4 No exposed fasteners permitted.
- .5 Overlap trim 6 mm onto panels.
- .6 Mechanical attachment:
 - .1 To concrete or solid masonry use lag screw and expansion bolts or screws and fibre plugs as appropriate for stresses involved.
 - .2 To hollow masonry use toggle bolts or equivalent.
 - .3 To wood or sheet metal use screws. Secure into framing members in stud walls.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements.
 - .1 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 01 00 10 - General Requirements.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 00 10 – General Requirements.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by tackboard installation.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 00 - Cleaning.
- .3 Section 01 74 19 - Waste Management and Disposal.
- .4 Section 01 78 00 - Closeout Submittals.

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A 653/A 653M, Standard Specification for Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
 - .3 ASTM B 32, Standard Specification for Solder Metal.
 - .4 ASTM B 456, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 31-GP-107Ma, Non-Inhibited Phosphoric Acid Base Metal Conditioner and Rust Remover.
 - .2 CGSB 41-GP-6M, Sheets, Thermosetting Polyester Plastics, Glass Fibre Reinforced.
- .3 CSA Group (CSA)
 - .1 CSA W47.2, Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSA W59, Welded Steel Construction (Metal Arc Welding).
 - .3 CSA W59.2, Welded Aluminum Construction.
- .4 Canadian Sheet Steel Building Institute (CSSBI)
 - .1 CSSBI SSF 6, Sheet Steel Facts #6, Metallic Coated Sheet Steel for Structural Building Products.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .6 Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.
 - .1 MPI #76, Quick Dry Alkyd Metal Primer.
 - .2 MPI #96, Quick Dry Enamel Gloss.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for signage and include product characteristics, performance criteria, physical size, finish and

limitations.

- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Submit catalogue sheets and full-size templates.
 - .3 Indicate materials, thicknesses, sizes, finishes, colours, construction details, removable and interchangeable components, electrical components specifications and power loads, wiring terminal box locations, lamp centres and overlaps, access panels, mounting methods, schedule of signs.
 - .4 Submit full size templates drawn-to-scale details for individually fabricated or incised lettering indicating word and letter spacing.
- .4 Samples:
 - .1 Submit duplicate representative sample of each type sign, sign image and mounting method including, but not limited to: graphics, cast letters, sign box installation method, channel letters, and wall plates fixed mounting installation method.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for illuminated signs for incorporation into manual.

1.5 QUALITY ASSURANCE

- .1 Welding Certification in accordance with CSA W47.2.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect specified materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Aluminum extrusions: to designation AA 6063-T5 or AA 6006-T5.
- .2 Sheet aluminum: anodizing quality.
- .3 Prefinished sheet aluminum: plain utility sheet with manufacturer applied baked enamel finish to designation AA 6006, 0.25 mm thick on face and 0.0076 mm thick on back.

- .4 Prefinished sheet steel: conforming to CSSBI SSF 6: for corrosive environment: in colours selected from manufacturer's standard range or as indicated.
- .5 Galvanized steel sheet to ASTM A 653/A 653M: Commercial Quality with mill phosphatized Z275 or ZF75 coating, accept where colour coating is required.
- .6 Acrylic sheet: polymethylmethacrylate (PMMA) cast sheet suitable for intended use in sign fabrication, colours as indicated.
- .7 Fibreglass sheet: to CGSB 41-GP-6M, flat sheet, smooth finish, colours as indicated.
- .8 Engraving sheet: lamicoid 3.2 mm thick plastic sheet, black core.
- .9 Electrical components: CSA approved as indicated.
- .10 Welding materials: to CSA W59.
- .11 Solder: to ASTM B 32, Type Sn50.
- .12 Self-stick foam tape: 3.2 mm thick, 352.4 kg/m³ density polyurethane open-cell foam tape for sign purposes, with synthetic self-stick adhesive on both sides.
 - .1 Width: as indicated to suit sign sizes.
- .13 Adhesives, paints, sealants and solvents for acrylic sheet: type recommended by sheet manufacturer for applicable condition.
- .14 Acrylic top-coat: clear, non-yellowing, exterior grade, satin finish, acrylic polyester resin protective coating, compatible with acrylic surface of type recommended by sheet manufacturer.
- .15 Bituminous paint: to MPI EXT 5.4D.

2.2 SIGN GRAPHICS

- .1 Cut and spray process: mask surfaces, accurately cut-out image, spray apply uniform coating to obtain opaque or translucent finish to match Consultant's sample.
- .2 Silk screen process: apply multi colour photographic produced silk screen printed images to face or back side of transparent sign faces; face side of opaque sign faces.
- .3 Engraving: apply sign images using pantograph mechanical engraving machine to obtain incised paint-filled letters as detailed or specified to match Consultant's sample.
- .4 Self-stick vinyl film: individual letters and numerals and symbols die cut from 0.1 mm thick integral colour, matte finish, exterior grade VC film, with self-stick adhesive backing.
- .5 Decals: silk screened or printed images on 0.051 mm, clear matte finish, mylar or PVC film, with self-stick adhesive backing.
 - .1 Protect image with laminated film overlay of same material as decal base.

2.3 CUT-OUT LETTERS

- .1 Cut letters and symbols from opaque coloured acrylic or plain aluminum sheet.

- .2 Helvetica typeface, upper and lower case: sizes and thicknesses as indicated.
 - .1 Make corners cutter radius.
- .3 Finish, after fabrication aluminum with clear anodizing or baked enamel.

2.4 CAST LETTERS

- .1 Cast letters of solid aluminum or plastic accurately formed to profiles as detailed; with smooth faces free from surface defects or blemishes.
- .2 Finish letters, after fabrication with clear anodizing or belt polished high lustre with acrylic topcoat to match Consultant's sample.

2.5 ILLUMINATED SIGN BOXES

- .1 Fabricate illuminated sign boxes as detailed of extruded aluminum with clear anodized finish.
- .2 Sign casings:
 - .1 Design, construct and reinforce sign casing to provide strong, rigid, self-supporting, weathertight and light-tight housing to accommodate sign faces and electrical components.
 - .1 Use one piece casing lengths except where joints indicated or approved by Consultant.
 - .2 Include matching end closures.
 - .3 Mechanically fasten intersecting members.
 - .2 Provide space in front of sign face for 3.2 mm acrylic lift in panel for message image.
 - .3 Provide access for installation, maintenance, and relamping, through removable sign face or access panel, having concealed latches to prevent unauthorized access.
 - .4 Provide for thermal movement, heat and moisture dissipation by approved non-staining, concealed methods.
 - .5 Include clear anodized aluminum reflectors, minimum 1.52 mm thick.
 - .1 Paint remainder of interior white.
 - .6 Fabricate overhead hangers, wall brackets, and wall fasteners for installation.
 - .1 Match exposed materials to sign casing.
 - .2 Concealed material: steel with galvanized finish.
- .3 Sign faces: clear or colour acrylic sheet 3.2 mm thick.
 - .1 Support face along top, leaving sides and bottom floating to permit unrestricted thermal movement.
 - .2 Join butting sign faces with clear transparent acrylic or PVC joining splines of approved type.
 - .3 Installed face to present rigid surface with minimal distortion: to match Consultant's approved sample method.
 - .4 Lift in panels: 3.2 mm clear acrylic panels for each message (pictograph or word).
 - .1 Panels capable of easy placement and removal yet secure when in place.
 - .2 Smooth on edges.
- .4 Sign graphics:
 - .1 Acrylic sign faces: apply graphics for silk screen, cut and spray, self-stick vinyl film, decals, cut-out acrylic letters, as indicated.

2.6 NON- ILLUMINATED SIGN BOXES

- .1 Fabricate sign as detailed of opaque black acrylic, PVC 3.2 mm thick.
- .2 Buff exposed edges and make radius corners.
- .3 Fabricate overhead hangers, wall brackets, or wall fasteners for installation.
 - .1 Exposed materials: compatible with materials used on illuminated signs.
 - .2 Concealed materials: steel with galvanized finish to produce reasonably rigid sign.
- .4 Sign faces:
 - .1 Fabricate sign faces of colour acrylic sheet 3.2 mm thick.
 - .2 Installed face to present rigid surface with minimal distortion: to match Consultant's approved sample method.
- .5 Sign graphics: apply by self-sticking vinyl film, decals or cut-out acrylic letters.

2.7 WALL PLATES

- .1 Plastic wall plates:
 - .1 Fabricate from colour acrylic sheet 6.4 mm thick. Sizes as indicated.
 - .2 Sign graphics: apply by paint filled engraving or self-stick vinyl film letters.
- .2 Metal wall plates:
 - .1 Fabricate from sheet aluminum sign plates, minimum 6.4 mm thick, with clear anodized finish.
 - .1 Sizes as indicated.
 - .2 Sign graphics: apply by engraving or self-stick vinyl letters.
- .3 Interchangeable mounting:
 - .1 Supply wall plates with approved type, semi-concealed, retaining holders that permit quick but vandal-resistant interchange of sign face.
 - .2 Exposed fasteners not permitted.
 - .3 Exposed portions to match sign face.
- .4 Fixed mounting:
 - .1 Prepare wall plates for fixing by concealed tamperproof clips to match Consultant's approval self-stick foam tape.
 - .2 Include back-up plates for fixing to uneven surfaces where required.
- .5 Bracket mounting:
 - .1 Fabricate brackets for wall projecting or ceiling suspended sign plates as detailed: of clear acrylic or clear anodized aluminum, 4.8 mm thick.

2.8 DOOR PLATES

- .1 Fabricate sign faces of colour acrylic sheet or clear anodized aluminum.
 - .1 Size: as indicated.
- .2 Sign graphics: apply by engraving or self-stick vinyl letters.
- .3 Interchangeable mounting:

- .1 Supply door plates with approved type, semi-concealed, retaining holders that permit quick but vandal-resistant interchange of sign face.
- .2 Exposed fasteners not permitted.
- .3 Exposed portions to match sign face.
- .4 Fixed mounting: use self-stick foam tape.
- .5 Mounting on transparent surfaces: use self-stick foam tape. Include blank back-up plate for opposite side.
- .6 Washroom pictographs: cut-out figures without backgrounds.

2.9 NUMBER PLATES

- .1 Fabricate number plates for columns, doors and windows of engraving sheet.
 - .1 Size: as indicated.
- .2 Engrave 9.5 mm high, single line numerals incised to expose contrasting coloured core.

2.10 SELF ILLUMINATING SIGNS

- .1 Fabricate sign faces of aluminum with adhesive vinyl.
 - .1 Size as indicated.
- .2 Fabricate sign graphics using non-radioactive pigment safe for use in toys.
 - .1 Graphics luminance: 15 mcd/m² after 10 minutes with minimum luminance of 25 lx at site.
 - .2 Graphics Colour: yellowish green.
 - .3 Background Colour: red.
 - .4 Graphics resistant to: solvent cleaners, gasoline, diesel fuel, detergent, and salt.

2.11 FABRICATION

- .1 Fabricate signs in accordance with details, specifications and shop drawings.
- .2 Build units square, true, accurate to size, free from visual or performance defects.
- .3 Fit and securely join sections to obtain tight, closed joints.
- .4 Allow for thermal movement without distortion of components.
- .5 Exposed fasteners of same finish and colour as base material permitted where approved by Consultant.
- .6 Polish exposed edges of plastic and metal to smooth, slightly convex profile.
- .7 Do steel welding to CSA W59 and aluminum welding to CSA W59.2.
 - .1 Finish exposed welds flush and smooth.
- .8 Apply bituminous paint to aluminum in contact with dissimilar metals, concrete or masonry.
- .9 Manufacturer's nameplates on sign surface permitted in non-visible locations in completed work.

2.12 FINISHES

- .1 Anodized aluminum:
 - .1 Colour finish: to match Consultant's sample.
- .2 Galvanized finish: on irregular shaped articles, 381 g/m² zinc coating to ASTM A 123/A 123M.
- .3 Baked enamel:
 - .1 One coat of conditioner to CGSB 31-GP-107M one coat of MPI #76 primer.
 - .2 At least two coats of MPI # 96.
 - .3 One coat on interior surfaces.
 - .4 Individually bake each coat.
- .4 Chrome and nickel plating: to ASTM B 456, polished finish.
- .5 Prefinished metals: see PART 2, article on MATERIALS.
- .6 Bronze finishes: to match Consultant's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for signage installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

- .1 Manufacturer's Instructions: compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheets.
- .2 Erect and secure signs plumb and level at elevations indicated or as directed by Consultant.
- .3 Comply with sign manufacturer's installation instructions and approved shop drawings.
- .4 Mechanical attachment:
 - .1 To concrete or solid masonry: use lag screws and expansion bolts or screws and fibre plugs, as appropriate for stresses involved.
 - .2 To hollow masonry: use toggle bolts or equivalent.
 - .3 To steel: use bolts with nut and lock washers, self-tapping screws.
 - .1 Do steel welding to CSA W59 and aluminum welding to CSA W59.2.
 - .2 Finish exposed welds flush and smooth.
 - .4 To wood: use screws.
 - .5 Secure into framing members behind stud walls or above ceilings.
 - .6 Mechanical fasteners on exterior: non-staining, non-ferrous type.

- .7 Fabricate special fasteners as required for installation conditions.
- .8 Mechanical fasteners and methods of attachment subject to Consultant's approval.
 - .1 Obtain Consultant's approval before fixing to structural steel.
- .5 Adhesive attachment:
 - .1 Use self-stick adhesive foam tape to manufacturer's instructions to fix sign and prevent "rocking".
 - .2 Keep tape maximum 1.6 mm from edges.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 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 01 74 00 - Cleaning.
 - .1 Leave signs clean.
 - .2 Remove debris from interior of sign boxes.
 - .3 Touch up damaged finishes.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements.
- .2 Section 07 92 00 - Joint Sealants

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM A 167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - .2 ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .3 ASTM A 924/A 924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- .2 CSA Group (CSA)
 - .1 CSA B651, Accessible Design for the Built Environment.
 - .2 CAN/CSA-Z809, Sustainable Forest Management.
- .3 Forest Stewardship Council (FSC)
 - .1 FSC-STD-01-001, FSC Principle and Criteria for Forest Stewardship.
- .4 National Electrical Manufacturers' Association (NEMA)
 - .1 ANSI/NEMA LD-3, High Pressure Laminates.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for shower and dressing compartments and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS SDS. Indicate VOC's:
 - .1 For caulking materials during application and curing.
 - .2 For adhesives.
 - .3 For laminates.
- .3 Installation Drawings:
 - .1 Submit installation drawings.
 - .2 Indicate fabrication details, plans, elevations, hardware, and installation details.
- .4 Samples:
 - .1 Submit duplicate 300 x 300 mm samples of panel showing finishes, edge and corner construction and core construction.
 - .2 Submit duplicate representative samples of each hardware item, including brackets, fastenings and trim.

1.4 QUALITY ASSURANCE

- .1 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect shower and dressing compartments from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART-2 PRODUCTS

2.1 MATERIALS

- .1 Shower and dressing compartments.
- .2 Sheet steel: to ASTM A 653/A 653M with Z275 designation zinc coating. ASTM A 924/A 924M Commercial Quality.
- .3 Minimum steel core thickness:
 - .1 Doors and panels: 0.80 mm.
 - .2 Pilaster: 1.0 mm.
 - .3 Reinforcement: 3.0 mm.
- .4 Core material:
 - .1 CAN/CSA-Z809 or FSC or SFI certified
 - .2 Urea-formaldehyde free.
- .5 Compartment seats: laminated hard wood with varnish finish to CAN/CGSB-1.36.
- .6 Headrails: 25 mm x 41 mm x 2 mm thick, clear anodized, extruded aluminum, anti-grip design, preformed socket brackets.
- .7 Stainless steel sheet metal: to ASTM A 167, Type 304, with #4 finish.
- .8 Pilaster shoe: 0.80 mm thick stainless steel, 75 mm high.
- .9 Curtain rods and hooks: 25 mm diameter 1.2 mm wall thickness stainless steel tubing.

- .10 Shower curtain: anti-bacterial fire resistive self-extinguishing vinyl laminated fabric.
- .11 Attachment: stainless steel tamperproof type screws and bolts.

2.2 COMPONENTS

- .1 Hinges:
 - .1 Heavy duty, nylon bushings.
 - .2 Material/finish: stainless steel.
 - .3 Swing: inward.
 - .4 Return movement: gravity, non-rising.
 - .5 Adjustable door-open angle.
 - .6 Emergency access feature.
- .2 Latch set: surface mounted, built-in emergency access feature, occupancy indicator, combination latch, doorstop, keeper and bumper, stainless steel.
- .3 Wall and connecting brackets: stainless steel extrusion or casting.
- .4 Coat hook: combination hook and rubber door bumper, stainless steel.
- .5 Door pull barrier-free: type suited for out swinging doors, stainless steel.

2.3 FABRICATION

- .1 Doors and panels: 25 mm thick, two steel sheets faces bonded to honeycomb core panel to sizes indicated.
- .2 Pilasters: 32 mm thick, constructed same as door, to sizes indicated.

2.4 FINISHES

- .1 Clean, degrease and neutralize steel components with phosphate or chromate treatment.
- .2 Spray apply primer to CAN/CGSB-1.81 coat.
- .3 Spray apply finish enamel to CAN/CGSB-1.104, type 2, semi-gloss, 2 coats, minimum 0.025 mm thick.
- .4 Finish: doors and pilaster/panels same colour.

PART-3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for shower and dressing compartment installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after

receipt of written approval to proceed from Consultant.

3.2 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.3 PREPARATION

- .1 Ensure supplementary anchorage, required, is in place.

3.4 ERECTION

- .1 Do work in accordance with CSA B651 and manufacturer's written instructions.
- .2 Partition erection.
 - .1 Install partitions secure, plumb and square.
 - .2 Leave 12 mm space between wall and panel or end pilaster.
 - .3 Anchor mounting brackets to masonry-concrete surfaces using screws and shields, to blocking/backing must be provided hollow walls threaded rods to steel supports with bolts in threaded holes.
 - .4 Attach panel and pilaster to mounting brackets with through type sleeve bolt and nut.
 - .5 Provide for adjustment of floor braced pilasters variations with screw jack through steel saddles made integral with pilaster.
 - .1 Make adjustment and attachment of overhead pilasters through 16 mm steel channel fastened to floor.
 - .1 Conceal floor fixings with stainless steel shoes.
 - .6 Include templates and drilling dimensions for locating threaded studs through finished ceilings.
 - .7 Equip doors with hinges, latch set, and each stall with coat hook mounted on door, mounting heights 1680 mm.
 - .1 Adjust and align hardware for easy, proper function. Set door open position at 30 degrees to front.
 - .2 Install door bumper door mounted.
 - .8 Equip out swinging doors with door pulls on inside and outside of door in accordance with CSA B651.
 - .9 Install hardware grab bars, benches, curtain rods, mounting height 1905 mm, curtain hooks, curtain, with floor to bottom of curtain clearance of 200 mm.
- .3 Floor supported and overhead braced partition erection.
 - .1 Attach pilasters to floor with pilaster supports and level, plumb, and tighten installation with levelling device.
 - .2 Secure pilaster shoes in position.
 - .3 Secure headrail to pilaster face with not less than two fasteners per face.
 - .4 Set tops of doors parallel with overhead brace when doors are in closed position.

3.5 ADJUSTING

- .1 Adjust doors and locks for optimum, smooth operating condition.

- .2 Lubricate hardware and other moving parts.

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 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 01 74 00 - Cleaning.
 - .1 Clean surfaces after installation using manufacturer's recommended cleaning procedures.
 - .2 Clean aluminum with damp rag and approved non-abrasive cleaner.
 - .3 Clean and polish hardware and stainless components.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by shower and dressing compartment installation.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 00 - Cleaning.
- .3 Section 01 74 19 - Waste Management and Disposal.

1.2 REFERENCE STANDARDS

- .1 Aluminum Association (AA)
 - .1 AA DAF 45, Designation System for Aluminum Finishes.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for wall and corner guards and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS SDS. Indicate VOC's for material as follows:
 - .1 Caulking materials during application and curing.
 - .2 Adhesives.
- .3 Installation Drawings:
 - .1 Indicate on drawings large scale details, materials, finishes, dimensions, anchorage and assembly.
- .4 Samples:
 - .1 Submit duplicate 300 mm long samples of profiles and colours for corner and door frame, wall guards and trolley rail.

1.4 QUALITY ASSURANCE

- .1 Test Reports:
 - .1 Submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates:
 - .1 Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wall and corner guards from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 **Vinyl corner guard:** 2 mm thick, 51 x 51 mm size, 1220 mm long, with 3 mm radius corners, including purpose made extruded AA-6063-T6 aluminum alloy snap-in retainer, to profiles indicated, surface, adhesive mounted, colour selected from manufacturer's standard range by Consultant.
- .2 **Metal corner guards:** 2.5 mm thick, 51 x 51 mm size, 1220 mm long, with 3.2 mm corner radius type 302 satin finished stainless steel, with removable protective paper cover, to profiles indicated, surface, mechanically mounted.
- .3 **Wall bumper guard:** 2 mm thick, 200 mm x 25 mm size, vinyl, to profiles indicated, complete with end caps to match wall bumper guard material, 2 mm thick purpose made extruded snap-in retainer, surface mechanical mounted, colour selected from manufacturer's standard range by Consultant.
- .4 **Door frame bumper guards:** 2 mm thick, 76 mm x 76 mm size, 1700 mm long, with 90-degree bullnose, vinyl, profiled to fit door frame, with purpose made extruded snap-in retainer, colour selected from manufacturer's standard range by Consultant.
- .5 **Trolley rail guard:** high strength PVC compound, 30 mm wide x 200 mm high channel sections, including preformed end and corner sections, light striated surface, colour selected by from manufacturer's standard range Consultant, complete with galvanized steel mounted fixing brackets fastened at 90 mm maximum on centre.

2.2 ACCESSORIES

- .1 Fasteners: self-tapping stainless steel, flush mounting.
- .2 Adhesive: water resistant type as recommended by manufacturer for substrate.

2.3 FINISHES

- .1 Finish exposed surfaces of aluminum components in accordance with Aluminum Association Designation System for Aluminum Finishes.
- .2 Appearance and properties of anodized finishes designated by the Aluminum Association as Architectural Class 1, Architectural Class 2, and Protective and Decorative.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wall and corner guards installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.3 INSTALLATION

- .1 Install units on solid backing and erect with materials and components straight, tight and in alignment.
- .2 Mechanically fasten metal type wall guards at 200 mm maximum on centre with top surface 100 mm above finish floor line or as indicated, straight and level to variation plus or minus 3 mm over 3000 mm straight edge, non-cumulative.
- .3 Mechanically fasten corner guards and door frame bumpers to wall substrate at 200 mm on centre or as indicated. Provide additional anchorage at corner guards with stainless steel fasteners or expansion screws at 200 mm centres.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements.
 - .1 Leave Work area clean at end of each day.
- .2 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .3 Clean surfaces after installation using manufacturer's written recommended cleaning procedures.
- .4 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.
- .5 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements.
- .6 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by wall and corner guards installation.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 00 - Cleaning.
- .3 Section 01 74 19 - Waste Management and Disposal.
- .4 Section 01 78 00 - Closeout Submittals.
- .5 Section 08 80 00 - Glazing.

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM A 167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - .2 ASTM B 456, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
 - .3 ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 CSA Group (CSA)
 - .1 CAN/CSA-B651, Accessible Design for the Built Environment.
 - .2 CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Indicate size and description of components, base material, surface finish inside and out, hardware and locks, attachment devices, description of rough-in-frame, building-in details of anchors for grab bars.
- .4 Samples:
 - .1 Submit samples for review and approval.
 - .2 Samples will be returned for inclusion into work.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for toilet and bath accessories for incorporation into manual specified in Section 01 00 10 - General Requirements.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Tools:
 - .1 Provide special tools required for assembly, disassembly or removal for toilet and bath accessories in accordance with requirements specified in Section 01 00 10 - General Requirements.
 - .2 Deliver special tools to Owner.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect toilet and bathroom accessories from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, and packaging materials in accordance with Section 01 00 10 - General Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Sheet steel: to ASTM A 653/A 653M with ZF001 designation zinc coating.
- .2 Stainless steel sheet metal: to ASTM A 167, Type 304, with #4 finish.
- .3 Stainless steel tubing: Type 304, commercial grade, seamless welded, 1.2 mm wall thickness.
- .4 Fasteners: concealed screws and bolts hot dip galvanized, exposed fasteners to match face of unit. Expansion shields fibre, lead or rubber as recommended by accessory manufacturer for component and its intended use.

2.2 COMPONENTS

- .1 **Toilet tissue dispenser:** double fold tissue, stainless steel cabinet, hinged front panel, refill indicator slot, lock and key, cabinet capacity of 1000 tissues.
- .2 **Toilet tissue dispenser:** double roll type, surface mounted, chrome plated steel frame, capacity of 500 double ply roll, roll under spring tension for controlled delivery.
- .3 **Paper towel dispenser:** for folded and roll paper towels, stainless steel cabinet, hinged front panel, refill indicator slot, lock and key, recessed mounted.
- .4 **Facial tissue dispenser:** surface mounted wall unit, capacity of one box of 300 facial tissues, tamper proof lock and key.

- .5 **Cup dispenser:** surface mounted wall unit, stainless steel, capacity 150 paper cups 200 ml, lock and key.
- .6 **Combination towel dispenser/waste receptacle:** recessed wall unit, approximately 430 mm wide, 1390 mm high, 190 mm deep. Interior of 0.8 mm galvanized steel, exterior of 0.8 mm stainless steel. Suitable for dispensing folded or roll paper towels. Removable galvanized steel waste receptacle, lockable access door with continuous full height stainless steel hinge.
- .7 **Soap dispenser:** liquid push-in valve 152 mm spout, self-contained 1.5 L tank, stainless steel piston and valve assembly, tamper proof filler lock, under counter mounted, exposed metal components chrome plated.
- .8 **Feminine napkin/tampon dispenser:** stainless steel recessed unit including rough-in frame, minimum capacity 15 napkins and 20 tampons, free operation, key locked, continuous hinge front panel.
- .9 **Feminine napkin disposal bin:** stainless steel, recessed unit including rough-in frame, continuous hinged door, self-closing, embossed with "napkin disposal", "receptacle de serviette-sanitaire", and universally accepted symbol, removable stainless-steel receptacles fitted with spring clip for deodorizer block.
- .10 **Hand dryer:** listed under re-examination service of ULC and CSA approved.
 - .1 Mounting surface.
 - .2 Wall box: 16-gauge steel.
 - .3 Cover: stainless steel.
 - .4 Motor: universal type, 74.6 kW, 7500 RPM, resilient mounting, sealed, lubricated bearings, fuse protected, 120 V.
 - .5 Fan: double inlet centrifugal type, dynamically balanced, directly mounted on motor shaft, 56.6 L/s.
 - .6 Heating element: protected by an automatic, resetting circuit breaker, isolated from nozzle.
 - .7 Timer: cam operated mechanical type designed to operate hand dryer for not less than 30 seconds field adjustable.
 - .8 Electronic dryer: power controlled by infrared admitting, receiving electronic control device positioned to dryer on when hands are placed under nozzle. Operation to continue for no more than 80 seconds of continued use.
 - .9 Nozzle: stainless steel, 360 degrees revolving.
- .11 **Shower seat:** wall mounted folding hinged, stainless steel.
- .12 **Towel holder:** wall mounted, stainless rod, 215 mm deep x 610 mm wide.
- .13 **Towel bar:** 25 mm diameter stainless steel tubing, stainless steel end brackets, concealed fasteners, 610 mm long.
- .14 **Grab bars:** 38 mm diameter x 1.6 mm wall tubing of stainless steel, 76 mm diameter wall flanges, concealed screw attachment, flanges welded to tubular bar, provided with steel back plates and all accessories. Knurl bar at area of hand grips. Grab bar material and anchorage to withstand downward pull of 2.2 kN.
- .15 **Soap holder:** under mounted type, stainless steel, flush screws.

- .16 **Recessed soap holder:** recessed stainless steel 158 x 158 mm soap tray with integral grab bar, extended lip and steel backplate.
- .17 **Tumbler and toothbrush holder:** surface mounted. Approximate size: 190 x 220 mm. Satin chrome finish.
- .18 **Deodorant block holders:** 200 x 75 mm perforated design, chrome plated.
- .19 **Robe hook:** stainless steel with 75 mm projection.
- .20 **Waste receptacle:** recessed type, size 400 x 195 mm x 980 mm high, satin-finish stainless steel.
- .21 **Tilt mirror:** wall mounted unit, fixed framed mirror 6 mm, stainless steel frame with integral shelf.
- .22 **Shelf:** surface mounted, 200 deep, 400 wide, stainless steel.

2.3 FABRICATION

- .1 Weld and grind joints of fabricated components flush and smooth. Use mechanical fasteners only where approved.
- .2 Wherever possible form exposed surfaces from one sheet of stock, free of joints.
- .3 Brake form sheet metal work with 1.5 mm radius bends.
- .4 Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.
- .5 Back paint components where contact is made with building finishes to prevent electrolysis.
- .6 Hot dip galvanize concealed ferrous metal anchors and fastening devices to CAN/CSA-G164.
- .7 Shop assemble components and package complete with anchors and fittings.
- .8 Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates, details and instructions for building in anchors and inserts.
- .9 Provide steel anchor plates and components for installation on studding and building framing.

2.4 FINISHES

- .1 Chrome and nickel plating: to ASTM B 456, satin finish.
- .2 Manufacturer's or brand names on face of units not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 **Verification of Conditions:** verify that conditions of substrates and surfaces to receive toilet and bathroom accessories previously installed under other Sections or Contracts are acceptable for product installation in accordance with manufacturer's instructions prior to toilet and bathroom

accessories installation.

- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval from Consultant.

3.2 INSTALLATION

- .1 Install and secure accessories rigidly in place as follows:
 - .1 Stud walls: install steel back-plate to stud prior to plaster or drywall finish. Provide plate with threaded studs or plugs.
 - .2 Hollow masonry units, existing plaster or drywall: use toggle bolts drilled into cell or wall cavity.
 - .3 Solid masonry, marble, stone or concrete: use bolt with lead expansion sleeve set into drilled hole.
 - .4 Toilet and shower compartments: use male to female through bolts.
- .2 Install grab bars on built-in anchors provided by bar manufacturer.
- .3 Use tamper proof screws/bolts for fasteners.
- .4 Fill units with necessary supplies shortly before final acceptance of building.
- .5 Install mirrors in accordance with Section 08 80 00 - Glazing.

3.3 ADJUSTING

- .1 Adjust toilet and bathroom accessories components and systems for correct function and operation in accordance with manufacturer's written instructions.
- .2 Lubricate moving parts to operate smoothly and fit accurately.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements.
- .2 Leave Work area clean at end of each day.
- .3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements.
- .4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by toilet and bathroom accessories installation.

3.6 SCHEDULE

- .1 Locate accessories where indicated and as follows. Exact locations determined by Consultant and Owner.
- .2 Toilet tissue dispenser: one in each toilet compartment mounting height 660 mm above finished floor.
- .3 Paper towel dispenser: one per two wash basins. Maximum height of dispenser and operable part from floor 1200 mm.
- .4 Facial tissue dispenser: one in each washroom, maximum height of dispenser part from floor 1200 mm.
- .5 Cup dispenser: one in each washroom, maximum height of dispenser part from floor 1200 mm.
- .6 Combination towel dispenser/waste receptacles: one in each washroom or where indicated. Maximum height of dispenser and operable part from floor 1200 mm.
- .7 Soap dispenser: one at each wash basin.
- .8 Feminine napkin/tampon dispenser: one for each female washroom. Maximum height of dispenser and operable part from floor 1200 mm.
- .9 Feminine napkin disposal bin: one in each female toilet compartment mounting height 900 mm above finished floor.
- .10 Hand dryer: one in each washroom. Maximum height of dispenser and operable part from floor 1200 mm.
- .11 Shower seat: one at each shower, mounting height from floor 450 mm.
- .12 Towel holder: one at each shower, mounting height from floor 1200 mm.
- .13 Towel bar: one adjacent to each shower unit mounting height 1200 mm above finished floor.
- .14 Grab bar: two in each handicapped toilet compartment. Height of grab bar from floor 750 mm. Side grab bar: maximum distance from rear wall 300 mm, minimum distance passed front edge of toilet 450 mm.
- .15 Soap holder: one at each bathtub and shower. Maximum height from floor 1200 mm.
- .16 Tumbler and toothbrush holder: one at each wash basin, mounting height from floor 1200 mm.
- .17 Deodorant block holders: one for each two urinals.
- .18 Robe hook: one in each shower stall mounting height 1750 mm above finished floor.
- .19 Waste receptacle: one for each paper towel dispensers, adjacent to wash basin area. Maximum height of dispenser and operable part from floor 1200 mm.
- .20 Tilt mirror: one at each accessible wash basin, height of bottom edge of mirror from floor 1000 mm.

- .21 Shelf: one in each washroom, mounting height from floor 1000 mm.

END OF SECTION

FIRE PROTECTION

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PART-1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 01 33 00 - Submittal Procedures.
- .2 01 43 00 - Quality Assurance.
- .3 01 45 00 - Quality Control.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 10-2006, Standard for Portable Fire Extinguishers.

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies WHMIS SDS - Safety Data Sheets.
- .3 Provide shop drawings.
- .4 Quality Assurance Submittals:
 - .1 Manufacturer's Instructions: Submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.
 - .2 Manufacturer's Field Reports: submit manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3, SITE QUALITY CONTROL.
- .5 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 00 10 - General Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in a manner that will not endanger Project structure.
 - .2 Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - .3 Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - .4 Protect stored products from damage and liquids from freezing.

FIRE PROTECTION

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- .2 Waste Management and Disposal:
 - .1 Separate waste materials for recycling and re-use.

PART-2 PRODUCTS

2.1 WATER PUMP TANK EXTINGUISHERS

- .1 Stored water tank type, manual pump and handle with discharge hose and nozzle, stainless steel tank construction, ULC labelled for A class protection. 9.1 L size.

2.2 WATER PRESSURIZED EXTINGUISHERS

- .1 Stored pressure type, squeeze-grip operated of stainless-steel construction, ULC labelled for A class protection. 9.1 L size or as indicated.

2.3 MULTI-PURPOSE DRY CHEMICAL EXTINGUISHERS

- .1 Cartridge operated type or Stored pressure rechargeable type with hose and shut-off nozzle, ULC labelled for A, B and C class protection.
 - .1 Sizes 9 and 14 kg or as indicated.

2.4 ORDINARY DRY CHEMICAL EXTINGUISHERS

- .1 Cartridge operated type or Stored pressure rechargeable type with hose and shut-off nozzle, ULC labelled for B and C class protection.
 - .1 Sizes 9 and 14 kg or as indicated.

2.5 CARBON DIOXIDE

- .1 Extinguishers Insulated handle, hose and horn discharge assembly, self-closing lever or squeeze-grip operation, fully charged, ULC labelled for B and C class protection.
 - .1 Sizes 6.8 and 9.0 kg or as indicated.

2.6 DRY CHEMICAL (CLASS D)

- .1 Cartridge operated type or Stored pressure rechargeable type with hose and shut-off nozzle, ULC labelled for D class protection.
 - .1 Size 13.6 kg or as indicated.

2.7 KITCHEN EXTINGUISHERS (CLASS K)

- .1 Cartridge operated type or Stored pressure rechargeable type ULC labelled for K class protection.
 - .1 Size 6.0 litres or as indicated.

2.8 EXTINGUISHER BRACKETS

- .1 Type recommended by extinguisher manufacturer.

FIRE PROTECTION

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2.9 CABINETS

- .1 Flush, surface or semi-recessed type as indicated, constructed of 1.6 mm thick steel, 180 degrees opening door of 2.5 mm thick steel with latching device.
- .2 Cabinet to maintain fire resistive rating of construction in which they occur.
- .3 Cabinet door: with 5 mm full glass panel.
- .4 Finish:
 - .1 Tub: prime coated.
 - .2 Door and frame: No.4 satin finish stainless steel.

2.10 IDENTIFICATION

- .1 Identify extinguishers in accordance with recommendations of **ANSI/NFPA 10** and **CAN/ULC-S508**.
- .2 Attach bilingual tag, bar code or label to extinguishers, indicating month and year of installation. Provide space for service dates.

2.11 FIRE SAFETY BLANKETS

- .1 1800 x 1800 mm of silicone coated fibre glass in metal container.

PART-3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install or mount extinguishers in cabinets or on brackets in accordance with NFPA 10.
- .2 Install fire safety blankets as indicated.

3.3 SITE QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

END OF SECTION

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FIRE PROTECTION

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PART-1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements.
- .2 08 71 00 - Door Hardware

1.2 REFERENCE STANDARDS

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-44.40, Steel Clothing Locker.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for metal lockers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Canada.
 - .2 Indicate on drawings: type and class of locker, thicknesses of metal, fabricating and assembly methods, assembled banks of lockers, tops, rods, hooks, shelves, bases, trim, numbering, filler panels, end/back panels, doors, handles, locking method, ventilation method, and finishes.
- .4 Samples:
 - .1 Submit duplicate 100 x 100 mm samples of colour and finish on actual base metal.
 - .2 Samples will be returned for inclusion into work.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 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 metal lockers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 00 10 - General Requirements.

PART-2 PRODUCTS

2.1 MANUFACTURED UNITS

- .1 Lockers: to CAN/CGSB-44.40, Type 2 - Double tier locker, Class 2 - A bank of two or more lockers.
 - .1 Size: width, depth and height dimensions as indicated.
 - .2 Metal Thickness: hinges: 2.0 mm, frame: 1.6 mm, door: 1.0 mm, top: 0.85 mm, sides: 0.70 mm
 - .3 Assembly: knock down construction using pop rivet fastening.
 - .4 Top: flat.
 - .5 Doors: one-piece double-wall envelope construction, steel, door swing out.
 - .6 Door handle: recessed handle steel with bright chromium finish.
 - .7 Finish ends where lockers are exposed to match fronts.
 - .8 Base: Steel.

2.2 ACCESSORIES

- .1 Locking system: padlocks supplied by locker manufacturer.
- .2 Options: to CAN/CGSB-44.40, hanger rods, steel base, steel end panels, steel trim including corner angles jamb trim and fillers, manufacturer's standard number plates, coat hooks, metal chromium finish.

PART-3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates and surfaces to receive metal lockers previously installed under other Sections or Contracts are acceptable for product installation in accordance with manufacturer's instructions prior to metal locker installation.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval from Consultant.

3.2 INSTALLATION

- .1 Assemble and install lockers in accordance with manufacturer's written instructions.
- .2 Securely fasten lockers to grounds and nailing strips.
- .3 Install wall trim around recessed locker banks.
- .4 Install filler panels (false fronts) where indicated and where obstructions occur.
- .5 Install finished end panels to exposed ends of locker banks.
- .6 Install locker numbers and locks.

3.3 ADJUSTING

- .1 Adjust metal lockers for correct function and operation in accordance with manufacturer's written instructions.
- .2 Lubricate moving parts to operate smoothly and fit accurately.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements.
 - .1 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 01 00 10 - General Requirements.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by metal locker installation.

END OF SECTION

Part-1 GENERAL

1.1 RELATED REQUIREMENTS

- .1 Division Mechanical
- .2 Division Electrical

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/National Electrical Manufacturers Association (NEMA):
 - .1 ANSI/NEMA MG1-2011, Motors and Generators
- .2 CSA Group (CSA):
 - .1 ASME A17.1/CSA B44:16, Safety Code for Elevators and Escalators (Bi-national Standard, with ASME A17.1
 - .2 CSA B651-12, Accessible Design for the Built Environment
- .3 Efficiency Valuation Organization (EVO):
 - .1 International Performance Measurement and Verification Protocol (IPMVP)
 - .1 IPMVP 2007 Version

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings:
 - .1 Convene pre-installation meeting 1 week before beginning work of this Section and on-site installation, with Contractor and Consultant in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Coordination with other building construction subtrades.
 - .4 Review manufacturer's written installation instructions and warranty requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for passenger elevator(s) and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
 - .2 Indicate on drawings project layout, including details and information as follows:
 - .1 Size and location of machine and controller.
 - .2 Size and location of car, hoisting beam, guide rails, buffers stands and other

- components in hoistway.
- .3 Rail bracket spacing and maximum loads on guide rails.
- .4 Reactions at points of support.
- .5 Weights of principal components.
- .6 Top and bottom clearance and over travel of car.
- .7 Wiring diagrams with location of circuit breaker, switchboard panel or disconnect switch, light switch and feeder extension points in machine room.
- .8 Location in hoistway, machine room for connection of travelling cables for car light and telephone.
- .9 Location and size of access doors.
- .10 Loads on hoisting beams.
- .11 Expected heat generation of equipment in machine room.
- .12 Seismic design data and detailed calculations.
- .13 Include on general arrangement drawings:
 - .1 Type, size, location of hoistway entrances showing details of fastening to hoistway structure.
- .4 Samples:
 - .1 Submit duplicate 150 x 150 mm size samples, complete with colour schemes, for each as follows: floor material, car interior, car ceiling, car door, hoistway entrance door and frame finishes.
- .5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .6 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .7 Manufacturer's Instructions: submit manufacturer's installation instructions.
- .8 Manufacturer's Site Services: submit copies of manufacturer's site reports.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Project Record Documents:
 - .1 Record actual locations of equipment, names of equipment manufacturers and suppliers, concealed conduit and boxes, concealed devices, and disconnects.
- .3 Operation and Maintenance Data: submit operation and maintenance data for passenger elevators for incorporation into manual.
 - .1 Include description of elevator system's method of operation and control including [group supervisory control system], motor control system, door operation, signals, [firefighter's service], [emergency power operation], and special or non-standard features provided.
 - .2 Provide parts catalogues with complete list of equipment replacement parts with equipment description and identifying numbers.

- .3 Legible schematic wiring diagrams covering electrical equipment installed, including changes made in final work, with symbols listed corresponding to identity or markings on both machine room and hoistway apparatus.
- .4 Instruct Owner in maintenance of special finishes.

1.6 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer Qualifications: company or person experienced in performing work of this Section specializing in installation of work similar to that required for this project, with minimum five years documented experience and approved by elevator systems manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with Section Section 01 61 00 - Common Product Requirements.
- .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 and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect elevator components from nicks, scratches, and blemishes.
- .4 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in accordance with Section Section 01 74 19 - Waste Management and Disposal.

1.8 WARRANTY

- .1 Project Warranty: Contractor hereby warrants Passenger Elevator in accordance with General Conditions (GC) - CCDC-2 GC12.3, but for 60 months.
- .2 Manufacturer's Warranty: submit, for Consultant's acceptance, manufacturer's standard warranty document executed by authorized company official.

Part-2 Products

2.1 ELEVATOR SYSTEM DESCRIPTION

- .1 Hole-less Hydraulic.
- .2 Rated Load: 635 kg.
- .3 Rated Speed: 0.15 m/s.
- .4 Car Inside Dimensions:
 - .1 1219 mm wide x 1371 mm deep.
- .5 Hoistway Size: Refer to Architectural Drawings

- .6 Operation: Automatic. Down Collective.
- .7 Car Controls: Illuminated Type with faceplate in Stainless Steel #4 finish.
- .8 Hall Call Stations: Illuminated type. Stainless steel #4 Cover Plates.
- .9 Hoistway Entrances Size: 914 mm wide by 2032 mm high.
- .10 Entrance Type: Two Speed Sliding (Left or Right)
- .11 Door Operator: Automatic operator for hoistway and car. Opening and closing speed to suit Accessibility requirements.
- .12 Travel: Refer to Architectural Drawings. Maximum 9 metres.
- .13 Stops: Refer to Architectural Drawings. Maximum 7 floors.
- .14 Openings: Refer to Architectural Drawings.
 - .1 Hydraulic general purpose passenger elevator, gearless type.
 - .1 Traction machine located at bottom and immediately beside hoistway.
 - .2 Double compartment operation.
 - .3 Accessible Design in accordance with CSA B651.
 - .4 Bilingual Markings: include identification and instructions on operating panels and on signal equipment in English and French except where design is such that inference is obvious and readily understood.
- .15 Design and construct elevator in accordance with ASME A17.1/CSA B44, local codes and regulations
- .16 Power Supply: Refer to Electrical.
- .17 Lighting Supply: Refer to Electrical.
- .18 Elevator(s) must comply with the CSA B44 Elevator Code version currently in effect, including Supplements). Elevator(s) must meet the Appendix E Accessibility requirements.

2.2 CAR CAB SPECIFICATIONS

- .1 Shell Enclosure:
 - .1 Car Top: Minimum 16 ga. (1.5 mm) steel, white enamel finish
 - .2 Shell Walls: 16 ga. (1.5 mm) steel - cage frame type construction
 - .3 Strike Column: 16 ga. (1.5 mm) Stainless steel #4
 - .4 Fascia: 16 ga. (1.5 mm) Stainless steel #4
 - .5 Car Doors: 16 ga. (1.5 mm) Stainless steel #4 car door
- .2 Architectural Features:
 - .1 Side Walls: Raised plastic laminate hang-on panels
 - .2 Ceiling: Stainless Steel #4 Panel with compact LED down lights (CFLs)
 - .3 Front Return: Stainless steel #4
 - .4 Car Door: Stainless steel #4

- .5 Base: Stainless Steel # 4
- .6 Reveals: Black baked enamel finish
- .7 Finished Flooring: To be supplied and installed by Flooring Contractor
- .8 Hoistway Doors and Frames:
 - .1 At Typical Floors: Finish to be prime coat (ready for painting by others).
 - .2 At Main Floor: Stainless Steel #4
- .3 Supplementary Features:
 - .1 Lighting: LED Down Lights.
 - .2 Emergency Exit: Top exit in car top in accordance with CSA B44 Elevator Code.
 - .3 Car sill(s): Stainless Steel.
 - .4 Overall Height: 2134 mm (2134 mm clear inside).
 - .5 Car Operating Station: Top row of buttons located in compliance with CSA B44 Elevator Code Appendix E for accessibility
 - .6 Handrail: Located on all non-entrance walls: 6 mm x 102 mm Flat Stainless Steel #4
 - .7 Pad Hooks: Included.
 - .8 Protective Pads: One set.
- .4 Other Control Features:
 - .1 Battery Emergency Power for lowering of elevator and door opening.
 - .2 Door open button.
 - .3 Independent Service: Key switch.
 - .4 Phone Button to activate conversation.
 - .5 Light key switch.
 - .6 Run stop Key switch.
 - .7 Access Key switch.
- .5 Emergency Car Lighting:
 - .1 The emergency power unit to illuminate elevator car and provide current to alarm bell in the event of normal power failure. Equipment to comply with requirements of current CSA B44 Elevator Code.
- .6 Entrances:
 - .1 Shall be manufactured in accordance with procedures established by fire testing authorities and shall be labelled for a minimum of 1.5 hours.
- .7 Sight Guards:
 - .1 Sight guards shall be furnished on the leading edge of the doors to conceal the hoistway beyond the doors. Finish to match door panels.
- .8 Car Floor Indicator:
 - .1 One (1) to be installed in each car as part of the car station.
- .9 Hall Floor Indicator:
 - .1 One (1) for each elevator to be installed at each landing.
- .10 Certificate Frame
 - .1 Mounted on: Controller door

- .11 Car Lantern and Gong
 - .1 A directional lantern visible from the corridor to be provided in the car entrance on the strike post side.
- .12 Braille Floor Designation Tags:
 - .1 Place beside corresponding floor buttons on the car station.
- .13 Independent service operation.
- .14 Pressure switch.
- .15 Firefighters' Emergency Operation: Provide all requirements for FEO Phase I in each elevator.
- .16 Battery Powered Lowering.

2.3 CYLINDER AND PLUNGER (JACK UNIT)

- .1 The jack(s) shall be designed and constructed in accordance with the applicable requirements of the CSA B44 Elevator Code.
- .2 It shall be of sufficient size to lift the gross load the height specified and shall be factory tested to insure adequate strength and freedom from leakage.
- .3 The jack unit(s) shall consist of the following parts:
 - .1 A plunger of heavy seamless steel tubing accurately turned and polished
 - .2 a stop ring electrically welded to the plunger to prevent the plunger from leaving the cylinder
 - .3 a packing seal of suitable design and quality
 - .4 drip ring around the cylinder top
 - .5 cylinder constructed of steel pipe complete with a pipe connection and air bleeder.

2.4 ROPED HYDRAULIC FEATURES

- .1 Safety:
 - .1 An instantaneous safety shall be provided which will be actuated by a friction governor and governor tension sheave.
 - .2 The instantaneous safety shall be automatic and reset by running the car in the up direction.
- .2 Governor:
 - .1 The governor shall be located in the hoistway overhead.
 - .2 The governor shall include an electrically activated means of manually tripping governor from the machine room for annual no-load and five-year full-load safety tests.
 - .3 The design shall not require a governor access door.
- .3 Plungers, Cylinders, and Sheaves:
 - .1 A sheave shall be located at the top of each plunger and shall be guided through its

- travel by a set of plunger rails.
- .2 Each plunger and cylinder shall be installed plumb and shall operate freely with minimum friction.

- .4 Ropes: Minimum two (2) 9.5 mm aircraft cables. Ropes shall be fastened to the top of the cylinder jack stands, travel over the plunger sheave(s) and attach to the bottom of the elevator car frame.

2.5 PUMPING UNIT

- .1 Provide pumping unit of integral design, including electric motor connected to pump, hydraulic control system, storage tank, necessary piping connections, and controller, all compactly designed as single self-contained unit.
- .2 Mount motor and pump assembly on rubber-isolated inner base.

2.6 PUMP

- .1 Provide positive displacement screw-type pump designed and manufactured for elevator service, ensuring smooth operation.

2.7 MOTOR

- .1 Use alternating current motor, single or polyphase, squirrel cage induction type, designed to meet electro-hydraulic requirements.

2.8 HYDRAULIC CONTROL SYSTEM

- .1 Design hydraulic control system to be compact and suitable for operation under required pressures.
- .2 Use manifold control valve with up, down, and check valve sections.
- .3 Include control section with solenoid valves to direct main valve and control up and down starting, transition from full speed to levelling speed, up and down stops, pressure relief, and manual lowering.
- .4 Control down speed and up and down levelling at main valve sections.
- .5 Ensure all functions are fully adjustable for maximum smoothness and to meet contract conditions.
- .6 Pre-adjust all control systems at factory.
- .7 Provide manual lowering feature to permit slow speed lowering of elevator in event of power failure or for adjustment purposes.

2.9 LEVELLING DEVICE

- .1 Provide elevator with automatic levelling device that brings car to stop within 6 mm of landing level, regardless of load or direction of travel.
- .2 Maintain landing level within levelling zone, regardless of hoistway doors are open or closed.

2.10 STORAGE TANK

- .1 Construct storage tank from steel, providing cover and filter screen mounted over suction inlet.
- .2 Design tank to incorporate reserve capacity.
- .3 Provide initial supply of oil sufficient for proper operation.

2.11 PIPING

- .1 Install pipe of adequate size and thickness between pumping unit and cylinder head.
- .2 Provide shut-off valve for maintenance and adjusting purposes.

2.12 CONTROLLER

- .1 Provide microprocessor controller, including necessary starting switches of adequate size, along with all relays, switches, and hardware required to accomplish specified operation.
- .2 Provide overload protection to safeguard motor against overloading.

2.13 CAR STALL PROTECTIVE CIRCUIT

- .1 Provide protective circuit that will stop motor and pump and return car to its lowest landing if car does not reach its designed landing within predetermined time interval.
- .2 Allow normal exit from car but prevent further operation of elevator until the issue is corrected.

2.14 WIRING

- .1 Ensure all wiring and electrical interconnections comply with governing codes.
- .2 Use insulated wiring with flame-retardant and moisture-proof outer covering, and run it in conduit, tubing, or electrical wireways.
- .3 Suspend travelling cables flexibly and appropriately to relieve strain on individual conductors.

2.15 HOISTWAY OPERATING DEVICES

- .1 Provide normal terminal stopping devices.

- .2 If an emergency terminal stopping device is required, supply and arrange controller switches and circuitry to CSA B44 Elevator Code.

2.16 PIT SWITCH

- .1 Install emergency stop switch in pit.

2.17 PIT MAINTENANCE STAND

- .1 Provide non-removable means to mechanically hold the car above the pit floor, creating an area in the pit for maintenance and inspection as required by the CSA B44 Elevator Code.

2.18 PLATFORM

- .1 Fabricate car platform frame using formed and structural steel shapes, rigidly welded. Use wood for the sub-flooring.
- .2 Fireproof the underside of the platform.
- .3 The platform shall be manufactured by a CWB certified shop and be equipped with an aluminium threshold.

2.19 CAR FRAME

- .1 Provide suitable car frame fabricated from formed or structural steel members, with adequate bracing to support platform and car enclosure.
- .2 Ensure crosshead or rope connection member has sufficient strength to lift fully loaded car.

2.20 GUIDES

- .1 Furnish steel elevator guide rails to guide the car, ensuring they are erected plumb and securely fastened to building structure.
- .2 Mount sliding guides on top and bottom of car sling.

2.21 DOOR OPERATION

- .1 Power-operate doors on car and at hoistway entrances using quality operator mounted on top of car.
- .2 Ensure motor has positive control over door movement for smooth operation.
- .3 Provide infrared detector to trigger re-opening if obstruction is sensed.
- .4 Make door operation automatic at each landing, with door opening initiated as car arrives at landing and closing after set time interval.

- .5 Install car door electric contact to prevent elevator from starting away from landing unless car door is closed.
- .6 Provide approved positive interlock for each hoistway entrance, preventing operation unless all doors are closed, and maintaining doors in their closed position while elevator is away from landing.
- .7 Provide emergency access to the hoistway as required by governing Codes.
- .8 Provide hoistway entrance of the type and size as described at each landing served.
- .9 Construct each entrance with flush hollow metal doors, built-in hanger assembly, frames for one-piece unit installation, extruded aluminum sill, fascia, toe guard, hanger cover, header, hanger track assembly, and formed structural strut supports.
- .10 Ensure entrance design and construction comply with OBC fire label requirements.
- .11 Provide sill supporting angles for flush hoistway construction.

2.22 TELEPHONE

- .1 Install approved AUTODIAL telephone compliant with Accessibility requirements of latest version of OBC as part of car station.
- .2 Provide separate phone line to elevator controller, located in elevator machine room.

2.23 NON-PROPRIETARY CONTROLS

- .1 Ensure elevating device control equipment is non-proprietary.
- .2 If site-specific service tool or on-board diagnostic tool is required to make control equipment non-proprietary, provide it with elevating device.
- .3 The tool must allow full access to fault codes and maintenance-related parameters and enable complete maintenance service by any properly licensed and qualified Elevator Contractor.
- .4 Provide user's manual with tool that defines and explains all error codes, including required fixes.
- .5 Ensure service tool remains property of building owner.

Part-3 EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for elevator installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied [and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

- .1 Install hoistway, machine room, and other elevator materials and components in accordance with ASME A17.1/CSA B44, local codes, regulations and manufacturer's written instructions

3.3 SITE QUALITY CONTROL

- .1 Manufacturer's Site Services:
 - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .2 Provide manufacturer's site 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, or other work, on which the work of this Section depends, is complete but before installation begins.
 - .2 Twice during progress of work at 25% and 60% complete.
 - .3 Upon completion of the Work, after cleaning is carried out.
 - .4 Obtain reports, within 3] days of review, and submit, immediately, to Consultant.

3.4 SITE TESTS

- .1 Perform and meet tests required by ASME A17.1/CSA B44.
- .2 Supply instruments and execute specific tests.
- .3 Furnish test and approval certificates issued by jurisdictional authorities.
- .4 At agreed time during twelve-month warranty period, and with building normally occupied using normal building traffic, conduct tests to verify performance. Furnish event recording of hall call

registrations, time initiated, and response time throughout entire normal working day.

3.5 ADJUSTING

- .1 Adjust door opening and closing times to suit persons with disabilities in accordance with Consultant instructions.
- .2 Adjust control system to cause elevators to answer hall calls during working day within performance criteria specified.
- .3 Adjust for smooth acceleration and deceleration of car so as not to cause passenger discomfort.
- .4 Adjust automatic floor levelling feature at each floor.

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
 - .1 Remove protective coverings from finished surfaces and components.
 - .2 Clean surfaces and components ready for inspection.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

3.7 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by passenger elevator installation.

3.8 MAINTENANCE

- .1 Furnish complete service and maintenance of elevator system components during building contract and warranty period.

- .2 Systematically; monthly examine, clean, adjust, and lubricate equipment as per planned maintenance tasks and frequencies.
- .3 Maintenance to include systematic examination, adjustment and lubrication of elevator equipment; repair or replace parts whenever required.
 - .1 Use genuine parts produced by the manufacturer of specific equipment.
 - .2 Replace wire rope as necessary to maintain required factor of safety.
- .4 Perform work without removing cars during peak traffic periods.
- .5 Provide emergency call back service at all hours for this maintenance period.
- .6 Maintain locally, near place of work, an adequate stock of parts for replacement or emergency purposes and have qualified installation personnel available to ensure fulfillment of this maintenance service without unreasonable loss of time.
- .7 Perform maintenance work using competent personnel, under supervision and in direct employ of elevator manufacturer.
- .8 Do not assign or transfer maintenance service to any agent or Subcontractor without prior written consent of Consultant.

END OF SECTION

1. General

1.01 RELATED REQUIREMENTS

- .1 Unless otherwise noted, this Section is common to Sections of Division 21, Division 22, Division 23 and Division 25, and supplements each Section and read accordingly.
- .2 Division 00 and Division 01.
- .3 Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or 01 to take precedence, as confirmed with Owner and reviewed with Consultant prior to Bid submission.
- .4 Advise product manufacturer and vendors, and trades of each Section, of requirements of this Section. Product manufacturers and vendors are responsible for complying with specified product requirements.

1.02 REFERENCE STANDARDS

- .1 American National Standards Institute/American Society of Heating, Refrigeration and Air Conditioning Engineers/Illuminating Engineers Society (ANSI/ASHRAE/IES):
 - .1 ANSI/ASHRAE/IES Standard 90.1-[2022] (SI Edition), Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group (CSA):
 - .1 CSA C235-[19], Preferred Voltage Levels for AC Systems up to 50 000 V.
- .3 National Research Council Canada (NRC):
 - .1 NBC-[2020], National Building Code of Canada.

1.03 DEFINITIONS

- .1 AHJ: Authority having jurisdiction.
- .2 As noted: Directs reader to refer to schedules, drawings (layouts, riser diagrams, schematics, details) and Specification for additional information.
- .3 BAS: Building Automation System. Equivalent terms include Building Management System (BMS), Energy Management and Control System (EMCS) or Facility Management System (FMS). Typically, generically referenced in Divisions other than Division 25. Refer to Division 25 for final terminology used and system requirements.
- .4 Compliance certificates: Approval documentation of products or installation work issued by AHJ or product manufacturers, as specified.
- .5 Concealed: Hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
- .6 Delete or Remove (and tenses of delete or remove): Disconnect, make safe, and remove obsolete materials in planned deconstruction and disassembly of mechanical and plumbing items from existing construction including removal of pipes, ductwork and associated products, taking care not to damage adjacent assemblies designated to remain. Legally dispose of deleted items off site. Patch and repair/finish surfaces to match adjoining similar construction. Re-program systems to suit deletions. Revise documentation identifications to suit deletions. Retain items indicated as removed and salvaged. Retain items indicated as removed and reinstalled.

- .7 Demolish: Delete or remove, and detach items from existing construction and if not indicated as retained or salvaged, legally dispose of items off site. Retain items indicated as removed and salvaged, or removed and reinstalled.
- .8 Electrical Divisions: Typically, refers to Divisions 26, 27, 28 and other Divisions as specifically noted and which work as defined in Specifications or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- .9 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
- .10 Exposed: Work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
- .11 Finished: When in description of area or part of area or product which receives finish such as paint, or in case of product may be factory finished.
- .12 Install (and tenses of install): Secure in position, connect, test, adjust, verify and certify complete, ready for its intended use.
- .13 Local: In context to authorities or codes or standards, means of place of Work, unless otherwise noted.
- .14 Mechanical Divisions: Typically, refers to Divisions 21, 22, 23, 25 and other Divisions as specifically noted and which work as defined in Specifications or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
- .15 Professional Engineer: Individuals registered or licensed in Place of Work, by respective provincial or territorial associations that regulate the practice of engineering in Canada.
- .16 Provision or provide (and tenses of provide): In context of products, means supply, install and test complete, ready for its intended use.
- .17 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, check for proper working condition and reinstall them where indicated.
- .18 Remove and Salvage: Detach items from existing construction and deliver them ready for reuse, to onsite storage areas, as reviewed with Consultant.
- .19 Supply: Procure, arrange for delivery to site, inspect, accept delivery and administer supply of products. Distribute to areas and provide manufacturer assistance for required onsite testing, initial start-up, programming, basic commissioning and verification work.
- .20 Wherever words "indicated", "shown", "noted", "listed", "scheduled" 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", "noted" or "scheduled" in Contract Documents. When such references are used and do not identify exactly where in Contract Documents to refer to, examine issued Contract Documents and if unable to locate, submit request for information to Consultant.
- .21 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 satisfaction of", or "submitted to" Consultant.

1.04 CONTRACT DOCUMENTS

- .1 Specification is typically generally arranged in coordination with guidelines of Construction Specifications Institute/Canadian Specifications Canada (CSI/CSC) 50 Division MasterFormat.

- .2 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 as complementary. Perform Work that is shown, specified, noted or reasonably implied on drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
- .3 Sections of Specifications generally designate a basic unit of work, and Sections are read as whole.
- .4 Except where specifically noted, Specification does not typically indicate specific number of items or quantities 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.
- .5 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and materials. Take accurate measurement of building on site. Do not scale Drawings, and do not use Drawings for prefabrication work.
- .6 Drawings convey scope of work and do not show architectural and structural details. Provide fittings, offsets, transformations and similar items required as a result of obstructions and other architectural or structural details not shown on Drawings.
- .7 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment or materials, other equipment or systems being installed, and of building, at no additional cost to Contract.
- .8 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. Review starter, MCC, VFD, and motor specification requirements of both Electrical and Mechanical Divisions specifications and drawings, prior to Bid submission. Review and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .9 If there is conflict or discrepancy between, among or within any provisions of Contract Documents, provisions establishing higher quality, manner or method of performing the Work, using more stringent standards, prevails, with intent that provisions which produce higher quality with higher levels of safety, reliability, durability, performance and service prevails.
- .10 Generally, documents govern in following order:
 - .1 Specification.
 - .2 Drawings of larger scale.
 - .3 Drawings of smaller scale.
 - .4 Drawings of later date when the scale of drawings is same.
- .11 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, notify Consultant.
- .12 Language within Specification is in many cases written in imperative mode for brevity. Clauses containing instructions or directions are directed to Contractor.
- .13 Drawings and Specifications are 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.

1.05 METRIC AND IMPERIAL MEASUREMENTS

- .1 Generally, metric units of measurement (typically SI) are given in Sections of Specification. Measurement conversions may be generally "soft" and rounded off from imperial units. Industry common standard units also are specified. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable governing code requirements, and as applicable, make accurate measurements onsite. Where significant discrepancies are found, notify Consultant for direction.
- .2 Some units are specified in imperial units with use based on common trade terms.

1.06 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 Consultant, prior to Bid Submittal, existing site conditions that will or may affect performance of Work in accordance with Documents. Failure to do so will not be grounds for additional costs.

1.07 SUBMITTALS

- .1 Submit electronic copies of submittals, unless otherwise noted.
- .2 Submit product data and shop drawings as specified in Sections.
- .3 When requested by AHJ, submit copies of drawings and product data. Obtain submission requirements from AHJ. Before making changes requested by AHJ, review with Consultant. Where required for permit approvals, submit plans before commencement of work.
- .4 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .5 Shop Drawings:
 - .1 Where specifically specified for products or work, submit shop drawings stamped and signed by Professional Engineer.
 - .2 At start-up meeting, review with Consultant, products for including in shop drawing submission. Prepare and submit list of products to Consultant for review.
 - .3 Properly identify each shop drawing or product data sheet, with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
 - .4 Limit shop drawing submissions specifically to product (not family of products), without extraneous materials such as manufacturer brochures and sales materials.
 - .5 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.
 - .6 Obtain shop drawings for submission from product manufacturer authorized representatives and supplemented with additional items specified herein.
 - .7 Do not order product until respective shop drawing review process has been properly reviewed with Consultant.

- .8 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.
- .9 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 for resubmitted.
- .10 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:
 - .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) - When Consultant review of shop drawing is final, Consultant to stamp shop drawing as respectively stated.
 - .2 "REVISE & RESUBMIT" - When Consultant review of shop drawing is not final, Consultant to stamp shop drawing as stated, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant notations and resubmit.
- .11 Submit for review, shop drawings showing in detail design, construction, and performance of equipment and materials as requested in Specification. Prior to ordering and delivery of product to site, submit shop drawings for Consultant review and recommendations for acceptance. Prepare and submit following as applicable to respective product submissions:
 - .1 Product data, types and ratings.
 - .2 Operating instructions and sequence of operations.
 - .3 Equipment dimension drawings including required clearances and service access requirements.
 - .4 Mounting arrangements.
 - .5 Equipment loads (self-weight, operating weight).
 - .6 System block diagrams.
 - .7 Connection wiring schematic diagrams.
 - .8 Functionality with integrated systems.
 - .9 Manufacturer certification of current model production.
 - .10 Certification of compliance to applicable codes.
 - .11 Spare parts.
 - .12 Maintenance schedules.
 - .13 Other items as listed in Specifications.
- .12 Identify required short circuit withstand ratings with respective mechanical HVAC equipment with multi-motor and combination loads.
- .13 Submit sound power levels with fan shop drawings and product data.
- .14 Identify with products, types of finishes and colours of final finishes. Submit colour samples/swatches.
- .15 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories and other items shown to verify coordinated installation.
- .16 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
- .17 Indicate on drawings, clearances for operation, maintenance, and replacement of equipment devices.

- .18 Supply opening sizes and locations to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
- .19 Submit product data of field applied glues, adhesives, solvent cements, paints, caulking, sealants, firestopping coatings and other similar materials, for Consultant review of VOC limits and chemical component limitations.
- .20 Indicate products having requirements for installation and energizing onsite soon after delivery to maintain manufacturer warranty and service life.
- .21 Submit manufacturer documentation on start-up and operating procedures.
- .22 Submit manufacturer recommended maintenance schedules and procedures.
- .23 Submit manufacturer recommended spare parts and maintenance materials and tools.
- .6 Additional Submittals:
 - .1 Interference drawings.
 - .2 Layout drawings of equipment and access doors.
 - .3 Copies of reflected ceiling plan drawings and wall elevation drawings showing proposed access door locations.
 - .4 Sleeving Drawings: Dimensioned location drawings indicating required sleeves and formed openings in structural poured concrete or precast concrete construction or in roofing, and locations of cutting or drilling required for work.
 - .5 Detailed section drawings of ceiling spaces.
 - .6 Backboard drawings.
 - .7 Drawing details of:
 - .1 Housekeeping pads (concrete pads).
 - .2 Inertia pads.
 - .3 Bases, supports, and anchor bolts.
 - .4 Seismic restraints as required.
 - .8 Permits and Fees:
 - .1 Determine appropriate respective AHJ for Work.
 - .2 Prior to start of construction, make application for approvals from AHJ, and obtain permits.
 - .3 Prior to start of Work, submit copy of permit or notification form and notification number issued by AHJ.
 - .9 Sustainability: Submit in accordance with Division 01 requirements.
 - .10 Samples:
 - .1 Submit samples for products as noted.
 - .2 Unless otherwise noted, do not use samples for construction of Work.
 - .3 Include:
 - .1 Product Finishes: Colour swatches/chits.
 - .2 Other items as noted herein this Section and in other Sections.
 - .3 [].
 - .11 Manufacturer procedures and recommendations for product onsite testing and verification.
 - .12 Field Quality Control Reports:
 - .1 Manufacturer Field Reports: Submit, manufacturer certified report, verifying compliance of Work.

- .2 Testing and Verification Reports: Submit testing and verification reports signed by testing technician for products as specified.
- .13 Compliance Certificates:
 - .1 Upon completion field quality control work, submit compliance certificates verifying installation and performance of installed systems and equipment.
 - .2 Upon completion of the Work submit certificate of acceptance from AHJ.

1.08 AS-BUILT DRAWINGS

- .1 Drawings for this project are prepared on CAD system using AutoCAD software of release version reviewed with Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from Consultant, at expense of \$200 CDN initial base plus \$25.00 CDN for each drawing up to first 10 drawings, and \$5.00 for each additional drawing thereafter. HST charged additionally. Drawings may also be used for preparation of layouts and interference drawings.
- .2 Drawings for this project are prepared on CAD system using Building Information Modelling (BIM) - Autodesk Revit Architecture (Revit) software of release version reviewed with Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from Consultant, at expense of \$200 CDN initial base plus \$25.00 CDN for each drawing up to first 10 drawings, and \$5.00 for each additional drawing thereafter. HST charged additionally. Drawings may also be used for preparation of layouts and interference drawings.
- .3 As work progresses at site, clearly mark in red in neat and legible manner on set of bound white prints of Contract drawings, changes and deviations from routing of services and locations of equipment shown on drawings, on daily basis, as required for Work. Use notes marked in red. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date, and available for periodic review. Mark changes as work progresses and as changes occur. Include following with as-built set:
 - .1 Dimensioned location of inaccessible concealed work.
 - .2 Locations of control devices with identification for each.
 - .3 Location and identification of devices in concealed locations such as accessible ceiling spaces and raised floors.
 - .4 For underground piping and ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories, as applicable, and locate and identify dimensions from benchmarks.
 - .5 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 drawings.
 - .6 Location of piping system air vents.
 - .7 Location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
 - .8 Changes to existing mechanical systems, plumbing systems, fire protection services, control systems and control wiring.
 - .9 Other items noted on drawings.
 - .10 Other items noted within Specifications.

- .4 Prior to start of Testing, Adjusting and Balancing (TAB) for HVAC, finalize production of as-built drawings. Use final reviewed "as-built" drawing set to provide REVIT files of drawings forming true "as-built" set of Contract drawings. Identify set as "Project Record Copy".
- .5 Arrange for and make payment to Consultant of respective trade of work to produce record CAD drawings of as-built work from Contractor provided as built white prints. Include cost of \$100 plus GST, for each drawing.
- .6 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". Save drawings as AutoCAD files and in pdf format and such that each drawing is not x-referenced but as complete drawing. Upload files of digital copies of final reviewed by Consultant as-built drawings to designated file sharing site.
- .7 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. Save drawings as AutoCAD files and in pdf format and such that each drawing is not X-referenced but as complete drawing.
- .8 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows:
"AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW
MECHANICAL/FIRE SUPPRESSION/PLUMBING SYSTEMS AS INSTALLED"
(Signature of Contractor) (Date).
- .9 Submit copies to Consultant for review and comments, and make corrections as recommended by Consultant.
- .10 Refer to Divisions 00 or 01, with respect to maintaining accurate record drawings.
- .11 For projects with phased turnover of project (refer to Division 01), review with Consultant completeness of as-built drawings prior to turnover of an area. Make copies of hand drawn interim as-built drawings available to Owner maintenance personnel.
- .12 Submit electronic version of completed reproducible as-built drawings with Operating and Maintenance (O & M) Manuals.
- .13 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .14 Submit copies of as-built drawings for inclusion in final testing, adjusting and balancing report.

1.09 OPERATION AND MAINTENANCE (O & M) MANUALS

- .1 Prepare and submit project specific, indexed copies of equipment manufacturer O & M instruction data manuals. Consolidate each copy of data in identified hard cover three "D" ring binder.
- .2 Operating and maintenance instructions relate to job specific equipment supplied under this project and relate to project building. Language used in manuals contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system/equipment.
- .3 Supply manuals in English language.
- .4 Include electronic PDF version saved on USB type flash drives.

- .5 Prepare O & M manuals for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .6 For each system and equipment identify manufacturer name, type, model year, ratings (performance, capacity, electrical data as applicable) and serial number.
- .7 O & M Data: Obtain operation and maintenance data for products for incorporation into manuals. Include following:
 - .1 Front Cover Clearly Labeled: Project name label; wording - "Mechanical Systems Operating and Maintenance Manual"; with specific system/equipment name highlighted, and date.
 - .2 Introduction sheet listing subcontractor and trades names, street addresses, telephone number and e-mail addresses.
 - .3 Equipment manufacturers authorized distributor, telephone number, e-mail and company website.
 - .4 Table of Contents sheet, and corresponding index tab sheets.
 - .5 Copy of each reviewed shop drawing. Limit shop drawing documentation to specific product requirements as specified for Shop Drawings.
 - .6 Product manufacturer name, type, model year, capacity and serial number.
 - .7 Description of systems and their controls. Include systems architecture and operating data.
 - .8 Parts lists with catalogue numbers.
 - .9 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .10 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment, including environmental controls.
 - .11 Valves schedule and flow diagrams indicating valve locations and normal position.
 - .12 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .13 Equipment with filters identified with type and size of filters.
 - .14 Colour-coding charts.
 - .15 Safety precautions.
 - .16 Maintenance and Operating:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Schedules of tasks, frequency, tools required and task time.
 - .3 Recommended spare parts and maintenance materials for systems and equipment.
 - .4 Contact names and addresses of servicing companies and locations where to obtain replacement parts.
 - .17 Performance Data:
 - .1 Equipment manufacturer certified factory test reports.
 - .2 Equipment manufacturer certified performance datasheets with point of operation as left after commissioning is complete.
 - .3 Equipment performance certified verification test results.
 - .4 Special performance data as specified.
 - .5 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

- .18 Procedures in event of equipment failure.
- .19 Copies of inspection reports or certificates issued by AHJ.
- .20 Copies of warranties.
- .21 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .22 Other items noted within Specifications.
- .8 Provide operating instructions on signage for specific equipment/systems as noted.
- .9 Submit copies of draft O & M manuals to Consultant in format reviewed with and recommended for acceptance by Consultant. Combine material as specified and not as individual submissions.
- .10 Make changes as reviewed by and recommended by Consultant and re-submit.
- .11 Additional Data: Prepare and insert into O & M manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .12 Prepare and submit final reviewed with Consultant O & M manuals, with Consultant comments incorporated. Submit as directed in Division 01.

1.10 CLOSEOUT SUBMITTALS

- .1 Prior to application for Substantial Performance of the Work, submit items and documentation noted, including following:
 - .1 O & M Manuals.
 - .2 As-built record drawings and associated data.
 - .3 Extended warranties for equipment as noted.
 - .4 Operating test certificates.
 - .5 Final commissioning 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 items as noted.

1.11 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials as specified, in accordance with Division 01 and manufacturer instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labeled with manufacturers name and address.
 - .2 Review and coordinate equipment deliveries with manufacturers and suppliers, and Consultant so equipment is delivered to site when it is required, or so it can be stored.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in accordance with manufacturers recommendations in clean, dry, and well-ventilated area onsite, as confirmed with the Owner and as reviewed with Consultant.
 - .2 Store and protect products from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new. Remove rejected material and equipment site.

- .4 Touch up damage to factory finishes. Use finishes to match factory finishes. Do not paint over nameplates or labels.
- .5 Hoisting and Transporting:
 - .1 Hoist and transport materials and equipment as required.
 - .2 Coordinate with Prime Contractor or General Contractor.
 - .3 Review procedures with Consultant.
 - .4 Review use of elevators and Owner permissions with Consultant. Review limitations of dimensions and loading of elevators that are permitted for use. Where such elevators are permitted for use, prepare schedule of use, detailing date and time frame, materials and equipment being transported and loads. Submit copy for Consultant review and recommendations for acceptance.
 - .5 Refer to requirements of Division 01.
- .4 Develop Construction Waste Management Plan in accordance Division 01.
- .5 Packaging Waste Management: Remove for reuse as specified in Division 01.

1.12 QUALITY ASSURANCE

- .1 Pre-Installation Meeting: Convene pre-installation meeting minimum one week prior to beginning onsite installations as reviewed with Consultant to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordinate with other building subtrades.
 - .4 Review manufacturer installation instructions and warranty requirements.
- .2 Submit following as specifically referenced for products in respective Sections, and as reviewed with Consultant:
 - .1 Factory inspection and test report for equipment. Include copy of each report with operating and maintenance manual project close-out data.
 - .2 Manufacturer/supplier installation compliance certificates.
 - .3 Onsite post installation test reports.

1.13 QUALITY OF WORK

- .1 Perform work so that items are and remain plumb, square and straight. Provide materials and equipment that are free from warping, twisting and other defects.
- .2 Install products in accordance with manufacturer instructions and recommended usage, unless otherwise noted and suiting intended installation requirements. Obtain instructions from manufacturer representative on special installation procedures.
- .3 Perform work in accordance with requirements of AHJ.
- .4 Where installation procedures conflict, review with Consultant prior to proceeding with installation and obtain direction.
- .5 Run exposed piping and duct runs including runs in ceiling spaces, parallel to building lines unless otherwise noted. Mount panels, boxes, covers, and such other products in similar manner.
- .6 Replace bolts and nuts in "stripped" condition. Replace bolts and nuts in "cross threaded" condition.

- .7 Avoid connection between dissimilar metals. Where such applications cannot be avoided, provide compound or other means recommended for such applications to prevent effects of contact between dissimilar materials.
- .8 Avoid use of material that corrodes when exposed to moisture, in wet locations or damp locations.
- .9 Conceal rough-in work in areas except where surface installations are specifically indicated. Where this becomes impossible and before proceeding with work, review with Consultant, to determine what adjustments to make.
- .10 Maintain superintendent onsite at times when work is being performed.

1.14 REGULATORY REQUIREMENTS

- .1 Comply with requirements of:
 - .1 Governing Ministry of Labour.
 - .2 Workplace Hazardous Materials Information System (WHMIS).
 - .3 Occupational Health and Safety Act.
 - .4 AHJ governing codes, regulations and standards.
- .2 Where code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, latest published edition adopted by and enforced by AHJ, unless edition date is specified. Comply with revisions, bulletins, supplementary standards or amendments issued by AHJ. Comply with federal and provincial codes and standards. Prior to start of Work, confirm edition dates being enforced for Project.
- .3 Where regulatory codes, standards and regulations are at variance with each other, or with Drawings or Specification, more stringent requirement applies. In doubt, review with Consultant.
- .4 Comply with requirements for barrier free access.
- .5 Perform Work in accordance with requirements of NBC and provincial building code, and codes and standards listed throughout Specification.
- .6 Provide mechanical piping system work, including equipment, in accordance with applicable requirements of AHJ and CSA B51. Where required for reviewing and registering design of pressure vessels, piping systems and fittings used to make them, mechanical work products are to bear Canadian Registration Number (CRN).
- .7 Electrical items associated with mechanical equipment: Certified and bear stamp or seal of recognized testing agency such as CSA, UL, ULC, ETL, or bear stamp to indicate special electrical utility approval.

1.15 DELEGATED DESIGN REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

- .1 Engage Professional Engineers to provide delegated design work of respective Sections, to prepare, design, and sign and seal engineered delegated design submittals.
- .2 Qualifications of Professional Engineers retained by Contractors to perform consulting services and provide engineered delegated designs with regard to Project work, such as seismic engineer, fire protection engineer or structural engineer:
 - .1 Legally qualified to practice professional engineering in Place of the Work.
 - .2 Experienced in work of respective Sections as noted.

- .3 Carry and pay for errors and omissions professional liability insurance in compliance with requirements of AHJ in Place of the Work.
- .3 Retained engineers' professional liability insurance protects Contractor 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 regard to the Work of this Contract.
- .4 Refer to Divisions 00 and 01 for liability insurance requirements:
 - .1 Coverage per General Conditions and Supplementary General Conditions.
 - .2 Insurance policy cannot be canceled or changed in any way without insurer giving Owner written notice.
- .5 Engineered delegated design submittals include, but not be limited to following:
 - .1 REVIT/CAD layout design drawings consisting of minimum 760 mm by 1050 mm detail working drawings of system layout and identifying as applicable:
 - .1 Head-end equipment.
 - .2 Devices.
 - .3 Applicable conduit/piping/ductwork layout and sizing.
 - .4 Applicable electrical point-to-point wiring diagrams.
 - .5 Data essential for proper installation of system.
 - .6 Details, plan view, elevations, and sections of system.
 - .7 Seismic restraints as required.
 - .2 Design data identifying:
 - .1 Calculations of system design listing design data used in preparing calculations, system layout, zoning and sizing, as applicable.
 - .2 Type and design of system.
 - .3 Certification that system has performed in manner intended.
 - .4 List of standards, codes and regulations that preparation of design was based.
 - .3 Manufacturer test data indicating results of factory tests on equipment prior to shipment.
 - .4 Items as noted in other Sections.
- .6 Responsibilities of Retained Engineers:
 - .1 Design, prepare, seal and sign engineered submittals.
 - .2 Perform periodic field reviews, including review of associated mock-ups where applicable, at locations wherever work as described by engineered submittal is in progress, during fabrication and installation of such work.
 - .3 Perform field reviews at intervals as necessary to progress of work.

- .4 Determine if work is proceeding in general conformity with Contract Documents including reviewed shop drawings and design calculations.
- .5 Submit field review report after each visit.
- .6 Submit field review reports to Consultant and AHJ as required.
- .7 Certifying that work has been supplied and installed in accordance with requirements of Contract Documents, AHJ and engineered submittal.

1.16 DESIGNATED SUBSTANCES

- .1 Hazardous substances removal by hazardous abatement specialist is not included as part of scope of this Project, unless otherwise noted.
- .2 Hazardous substances are as defined in Hazardous Products Act.
- .3 Immediately notify Consultant when materials suspected of containing hazardous substances are encountered and perform following:
 - .1 Stop work in area of suspected hazardous substances.
 - .2 Take preventative measures to limit user and worker exposure, provide barriers and other safety devices and do not disturb materials.
 - .3 Proceed with work only after written instructions have been received from Consultant.

1.17 PERMITS, CERTIFICATES, APPROVALS AND FEES

- .1 Contact and confirm with AHJ including utility providers, requirements for approvals from such authorities.
- .2 Obtain and pay for required permits and inspections and give required notices. Submit required applications, shop drawings and other information requested by AHJ.
- .3 Notify Consultant of proposed changes to documents requested by AHJ, and obtain Consultant recommendations prior to making changes.
- .4 Provide notification as requested by AHJ, for AHJ to perform onsite inspection of work. Allow sufficient lead time to correct deficiencies in manner not impeding schedule of completion of Work. Where defect, deficiency or non-compliance is found in work by inspection, provide for such inspection including related expenses, making good and return to site, until work is accepted by AHJ.
- .5 Coordinate work inspection reviews and approvals with AHJ ensuring construction schedule is not delayed. Promptly notify deficiencies to Consultant and submit reports and certificates to Consultant.
- .6 Obtain and submit to Consultant, compliance certificates issued by AHJ that verifies Work as installed is in accordance with rules and regulations of AHJ and are acceptable by AHJ.
- .7 Include in each copy of operating and maintenance instruction manuals, copies of compliance certificates issued by AHJ.

1.18 ACCEPTABLE PRODUCT MANUFACTURERS AND VENDORS

- .1 Products and services may generally be specified:
 - .1 With listing of acceptable manufacturers, vendors or service companies.
 - .2 With manufacturer model or series numbers listed.
 - .3 Base specified with manufacturer and model or series number.

- .2 Base Bid pricing on products supplied by base specified or listed acceptable companies. Unless otherwise noted, base pricing on model or series where listed. If only base specified company is specified with no other acceptable manufacturers listed, base pricing on base specified product.
- .3 Listing acceptable manufacturers/vendors does not imply automatic acceptance by Consultant or Owner. Ensure that any price quotations received, and submittals made are for products or services that meet or exceed specifications included herein. Ensure that acceptable products 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), and changes to associated or adjacent work resulting from provision of product supplied by manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in spaces where product named as acceptable is used in lieu of base specified product and dimensions of such product differs from base specified product, prepare and submit for review accurately dimensioned layouts of rooms/ceiling plans affected, identifying architectural and structural elements, systems and equipment to prove that product in space will fit and perform properly meeting design intent. There will be no increase in Contract Price for revisions.
- .4 Where products are listed as "equal to" or equivalent to" or "approved equal", other manufacturers may be proposed for review of acceptability by Consultant. Submit RFI with proposed manufacturer and model with detailed product specifications to Consultant during Bidding period. Acceptance is at sole discretion of Consultant and acceptance documented in addendum. Unless acceptance is given, do not include such products in Bid pricing.
- .5 When issued with Documents, complete and submit as directed, List of Proposed Acceptable Manufacturers and Vendors, or when directed by Consultant submit separate list of proposed manufacturers and vendors.
- .6 Changes to list of proposed manufacturers and vendors, initiated by Contractor after award of Contract may be considered by Consultant at Consultant discretion. Additional costs for such changes if approved by Owner and reviewed with and recommended for acceptance by Consultant, and costs for review, to be borne by Contractor.

1.19 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment (products). Where products are indicated, scheduled or specified, they establish performance and quality standard, and in some instances, dimensional standard.
- .2 Ensure that selected products meet design intent and specified quality standards, performance criteria and operating characteristics. Ensure that product dimensions, weight and special conditions can be accommodated in spaces designated for installations. Where selected product installation requires changes to base design of architectural or structural nature, or changes to interconnected electrical or mechanical components, costs of such changes is borne by Contractor.
- .3 Product Certifications:
 - .1 Canadian Standards Association (CSA) certifications or Underwriters Laboratories of Canada (ULC) listings markings.
 - .2 Certifications of standards as listed in trade Sections.
 - .3 References to UL listings of products to include requirements that products are also Underwriters Laboratories of Canada ULC/cUL listed for use in Canada.

- .4 Other certification organizations accredited by Standards Council of Canada to approve equipment may be acceptable subject to approval from AHJ and review with and recommended for acceptance by Consultant.
- .4 Provide systems and equipment that are most recent and up to date series/version of product available at time of shop drawing review process. Provide software of latest version available and with updates available at time of shop drawing review process. Provide software that is backwards compatible and such that future upgrades do not require hardware replacements or additions to utilize latest software.
- .5 Operating Voltages: In accordance with CSA C235.
- .6 Provide control devices and equipment rated for electrical utility connected line voltage operation, or where required low voltage, and operate at 60 Hz within normal operating limits established by above standard.
- .7 Equipment Withstand Ratings:
 - .1 Coordinate with Section 26 05 73 - Power System Studies, for short circuit current ratings (SCCR) determined from protection and coordination study results, for identification with HVAC equipment.
 - .2 Include additional applicable HVAC equipment with multi-motor and combination loads, industrial control panels and industrial machinery, in accordance with requirements of electrical code.
 - .3 Where SCCR are not identified, assume for pricing minimum 35 kA for small equipment and 65 kA for larger HVAC units.
 - .4 Prior to ordering equipment, review SCCR with Consultant and Division 26 Electrical Contractor. Identify SCCR with equipment shop drawings.
- .8 Factory assemble control panels and component assemblies.
- .9 Products (including associated installation and supporting hardware) located in non-climate-controlled environments: Features for corrosion-resistant, weather-resistant, able to withstand various climatic conditions including hot and cold temperatures.
- .10 Products located in public spaces and which are located within hands reach: Features for tamper-proof and impact-resistant.
- .11 Supply inserts, anchors, bolts, sleeves, ferrules and other items built into work of other Divisions, complete with necessary templates, instructions and assistance for locating and installing.
- .12 Utilize materials of same manufacturer for similar aspects of work, where practical. Utilize same common manufacturer for devices, such as valves, whether installed loose or in pre-manufactured component. Coordinate with each supplier and ensure conformance with this requirement. Identify deviations to Consultant and obtain Owner approval of change prior to proceeding with work.
- .13 Systems that are of technology that changes rapidly and are forever evolving and changing, may result in systems or equipment that may be outdated by time of installation. Include provisions allowing Owner option to select most updated technology. During shop drawing submission period include provisions for minimum 15 working days review time for Owner to review degree of technology of each system/equipment and determine acceptance and give Owner right to substitute more advanced technology subject to negotiated pricing and time constraints of project.

- .14 Applicable mechanical equipment has been selected to meet energy efficiency requirements of ANSI/ASHRAE/IES Standard 90.1. Submitted shop drawings and product data for such equipment to clearly identify compliance with this Standard or they will be returned for correction and re-submittal.

1.20 PRODUCT SUBSTITUTIONS

- .1 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 named as acceptable.
- .2 Certify in writing that proposed substitution meets space, design performance, power, energy consumption, and other requirements of listed acceptable product.
- .3 There will be no increase in Contract Price or change in Contract time by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution.
- .4 Consultant has sole discretion in accepting any such proposed substitution of product.
- .5 Do not order such products until they are approved by Owner, and reviewed with Consultant.
- .6 Unless otherwise noted, substitutions will not be considered by Consultant during Bid period unless permitted by Owner and directions and submission areas are provided on Bid Form.
- .7 At Consultant discretion, Consultant may consider substitutions if formally requested in writing minimum of 10 working days prior to Bid closing date.
- .8 Documents have been prepared based on product available at time of Project Bidding. If, after award of Contract, and if successful manufacturer can no longer supply product that meets base specifications, notify Consultant immediately. Obtain 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 credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems and other construction elements, include required revisions. Submit such revisions in detail to Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions.

1.21 CHANGES IN THE WORK

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of any work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation detailing proposed cost for executing change or revision.
- .2 Submit quotation as 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 Refer to and comply with Division 00 or 01 for allowable maximum percentages for overhead and profit.
- .4 Unless otherwise noted in Divisions 00 or 01, following additional requirements apply to 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 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 with additional reductions as follows:
 - .1 Steel pipe: 50%.
 - .2 Copper pipe, cast iron soil pipe and stainless steel pipe and fittings: 45%.
 - .3 Welded fittings: 50%.
 - .4 Grooved fittings: 30%.
 - .5 Threaded fittings: 40%.
 - .6 Cast iron screwed fittings: 40%.
 - .7 Copper fittings: 45%.
 - .8 Cast iron MJ fittings: 35%.
 - .9 Valves: 25%.
 - .10 Insulation materials: 35%.
 - .11 Other materials: 20%.
- .3 Mechanical labour unit costs are in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%.
- .4 Electrical labour unit costs are in accordance with National Electrical Contractors Association Manual of Labor Units at normal level, less 25%.
- .5 Costs for journeyman and apprentice labour to not exceed prevailing rates at time of execution of Contract and to reflect actual personnel performing work.
- .6 Cost for site superintendent to not exceed 10% of total hours of labour estimated for change or revision, and change or revision includes site superintendent involvement.
- .7 Costs for rental tools or equipment to not exceed local rental costs.
- .8 Overhead percentage deemed to cover quotation costs other than actual site labour and materials, and rentals.
- .9 Quotations, including those for deleted work, include 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 proper quotation enabling Consultant to expeditiously process quotation and issue Change Order will not be grounds for any additional change to Contract time.
- .6 Make requests for changes or revisions to work in writing to Consultant and, when accepted by Owner, Notice of Change to be issued.
- .7 Do not execute any change or revision until written authorization for change or revision has been obtained from Owner and reviewed with Consultant.

1.22 PROGRESS PAYMENT BREAKDOWN

- .1 Prior to submittal of first progress payment draw, submit detailed breakdown of work cost to assist Consultant in reviewing and recommending for acceptance progress payment claims.

- .2 Payment breakdown is subject to Owner approval and Consultant review and recommendations. Progress payments will not be processed until approved breakdown is in place. Breakdown to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including 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 they will be indicated on progress draw.

1.23 WARRANTY

- .1 Except where otherwise specified in Divisions 00 and 01, warrant work to be in accordance with Contract Documents and free from defects for a period of 1 year from date of issue of Certificate of Substantial Performance of the Work.
- .2 Where equipment includes extended warranty period, first year of warranty period is governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are direct from equipment manufacturer or supplier to Owner. Submit signed and dated copies of extended warranties with shop drawings and O & M manuals.
- .3 Warranty includes parts, labour, travel costs and living expenses incurred by manufacturer authorized technician to provide factory authorized onsite service.
- .4 Repair and/or replace 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 staff or agents is exempted.
- .5 Do not include Owner deductible amounts in warranties.
- .6 Warranties commence from time of Substantial Performance of the Work, regardless of what is noted within following Sections of Specification. Provide "bridging" or additional extended warranty period required from time that material is purchased until time of Substantial Performance of the Work.
- .7 Visit building during warranty period with Owner representatives. Owner organizes these visits. At these meetings, Owner representatives review performance of systems. When performance is satisfactory, then no further action is required. When unsatisfactory, then correct deficiencies. These site visits to occur:
 - .1 Once during first month of building operation.
 - .2 Once during third month of building operation.
 - .3 Once between fourth and tenth month in a season opposite to first and third month visits.

1.24 ALLOWANCES

- .1 Include in Bid amount a prime cost allowance in amount of _____.
- .2 Allowance is for _____.
- .3 Amount of allowance is net and includes product and material costs (less applicable trade discounts), including delivery to site and applicable taxes.
- .4 Other costs, including unloading and handling at site, installation, overhead and profit and other burdens are included in Bid amount, not in allowance.
- .5 Whenever costs are more or less than amount of allowance, adjust Contract amount accordingly by change order.

- .6 Materials and products under allowance are selected by Owner, and Owner reserves right to take entire or any part of allowance out of Contract amount, at any time.
- .7 Expenditure from above allowances may be made only upon receipt of order signed by Consultant. Relationship of Contractor and Subcontractors performing work paid out of allowances are strictly between Contractor and Contractor Subcontractors.

1.25 PRE-TENDERED EQUIPMENT

- .1 Refer to Appendix for complete information regarding scope of work for pre-tendered equipment. Equipment has been pre-tendered, ordered, and paid for by Owner. Include following under base Bid pricing:
 - .1 Coordination with respective equipment manufacturers with regards to delivery, unloading and acceptance on site.
 - .2 Inspection upon delivery and acceptance.
 - .3 Unloading, transporting and moving/hoisting into installation position.
 - .4 Takeover of administration of order and warranty obligations.
 - .5 Installation, connection, testing, and certification.
- .2 Coordinate with various manufacturers or suppliers of pre-ordered equipment and associated Work. During inspection of pre-ordered equipment and associated components at site, report deficiencies verbally and in writing to respective supplier and to Owner and be responsible for resolving such deficiencies directly with respective suppliers.
- .3 Be available for and attend factory testing at supplier offices of pre-ordered equipment and associated Work, as requested by Owner and reviewed with Consultant.
- .4 Coordinate final installation requirements with manufacturers or suppliers of pre-ordered equipment and associated Work.
- .5 For reference purposes, copy of shop drawings may be obtained from Consultant after order has been made.
- .6 Review installation schematics and diagrams, control system schematics, and wiring diagrams supplied by manufacturers or suppliers of pre-ordered equipment and associated Work. Coordinate interconnections with related various building systems.
- .7 Refer to respective equipment Section - Part 3 for additional installation requirements.
- .8 Refer also to Appendix for further details and requirements of pre-tendered equipment. Review issued documents and request further information from Consultant, if required. Include and incorporate required provisions and associated costs required for a complete installation.
- .9 Install equipment in accordance with drawing notes, specifications, and manufacturer instructions. Comply with Owner on-site standards and regulations.
- .10 Pre-tendered equipment includes following:
 - .1 .
 - .2 .
- .11 Obtain following from suppliers of pre-tendered equipment and submit to Owner:
 - .1 Operating and maintenance materials, testing and commissioning reports, inspection certificates, ULC approvals, AHJ approvals, warranties and other supplied documents. Organize and combine documents into manuals as specified in Division 01.

- .2 Spare parts, maintenance tools and kits, and loose accessories.
 - .12 Review and coordinate with each respective vendor of pre-tendered equipment, exact pre-tendered equipment, and accessories that are being supplied and/or installed, and services being performed by pre-tendered equipment vendor. With each respective pre-tender equipment vendor, determine installation products and services which are not included as part of pre-tender packages, but which need to be supplied by respective pre-tender equipment vendor in order to complete onsite installation of equipment. Obtain costs for supply of these items and include in Bid along with respective installation costs. Identify items as an itemized price included in Bid. Attach list of detailed items and itemized prices with Bid Form submission.
- 1.26 REQUEST FOR INFORMATION (RFI)**
- .1 Review contract documents for information prior to issuance of RFI during performance of Work. Where it is determined, at discretion of Owner and review with Consultant, that information requested in RFI was readily identifiable as part of Contract Documents, respective trades Contractor to be back-charged against their contract amount for time spent by Consultant and Owner in preparing response to RFI. Minimum amount of \$150 to be back charged against contract amount for any response to a readily identifiable RFI.
- 2. Products (Not Used)**
- 3. Execution (Not Used)**

END OF SECTION

1. General

1.01 RELATED REQUIREMENTS

- .1 Unless otherwise noted, this Section is common to Sections of Division 21, Division 22,
- .2 General instructions including administrative requirements and submittals: Section 23 00 10 - Mechanical Work General Instructions.
- .3 Common demolition requirements: Section 23 05 05 - Selective Demolition for HVAC.
- .4 Common pipe welding requirements: Section 23 05 18 - Pipe Welding.
- .5 Common vibration isolation requirements and seismic control requirements: Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- .6 Common product identification requirements: Section 23 05 53 - Identification for HVAC Piping and Equipment.
- .7 Advise product manufacturers, product vendors and subcontractors of requirements of this Section. Product manufacturers and product vendors are responsible for complying with specified product requirements.

1.02 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - .1 ASHRAE Handbook – Refrigeration, [2022].
- .2 ASTM International (ASTM):
 - .1 ASTM C679-[15(2022)], Standard Test Method for Tack-Free Time of Elastomeric Sealants.
 - .2 ASTM D6904-[03(2022)], Standard Practice for Resistance to Wind-Driven Rain for Exterior Coatings Applied on Masonry.
 - .3 ASTM G21-[15(2021)e1], Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .3 CSA Group (CSA):
 - .1 CSA A23.1-[19], Concrete Materials and Methods of Concrete Construction.
 - .2 CSA A23.2-[19], Test Methods and Standard Practices for Concrete.
 - .3 CSA B149.1-[20], Natural Gas and Propane Installation Code, along with [2020] TSSA Ontario amendments.
 - .4 CSA Z7396.1-[17], Medical Gas Pipeline Systems - Part 1: Pipelines for Medical Gases, Medical Vacuum, Medical Support Gases, and Anaesthetic Gas Scavenging Systems.
- .4 National Fire Protection Association (NFPA):
 - .1 NFPA 13-[2022], Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14-[2019], Standard for the Installation of Standpipe and Hose Systems.
 - .3 NFPA 2001-[2022], Standard on Clean Agent Fire Extinguishing Systems.
- .5 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S101-[14-REV3], Standard Method of Fire Endurance Tests of Building Construction and Materials.

- .2 CAN/ULC-102-[2019-(R2024)], Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .3 CAN/ULC-S115-[2023], Standard Method of Fire Tests of Firestop Systems.
- .4 CAN/ULC-S524-[2019], Standard for the Installation of Fire Alarm Systems.
- .5 CAN/ULC-S1001-[2023], Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.03 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, weight, service clearance requirements, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Where specifically specified for products or work, submit shop drawings stamped and signed by Professional Engineer.
 - .3 Include:
 - .1 Access Doors: Proposed type of access door where supplied under work of this Division, as well as electronic copies of reflected ceiling plan drawings and interior elevation drawings showing proposed access door locations.
 - .2 Firestopping and Smoke Seal Materials: With installation drawings and specific ULC certifications.
- .3 Sample Submittals:
 - .1 Submit samples of following:
 - .1 Paint colour chips or swatches.
 - .2 Each type of access door.
 - .3 [].
- .4 Submit compliance certificates, and testing and verification reports, as noted.

2. Products

2.01 SUSTAINABILITY REQUIREMENTS

- .1 Refer to and comply with sustainability requirements of Division 01.
- .2 Provide materials with applicable volatile organic compounds (VOC) requirements. Materials include but not limited to:
 - .1 Sealants.
 - .2 Air filters.
 - .3 Paints, primers and coatings.
 - .4 Adhesives.
 - .5 Insulations.
 - .6 Wood or composite wood products.

- .7 Other materials as noted in Sections.

2.02 FINISHES

- .1 Factory finish metal enclosure surfaces by application of rust-resistant primer inside and outside, and at least two-coats of finish enamel, with colour finish. Before manufacturing, review finishes with Consultant during shop drawing submission.
- .2 Paint outdoor equipment in weather-resistant, corrosion-resistant finish of equipment manufacturer standard ANSI finish colour, unless otherwise noted.
- .3 Refer to trade sections for additional painting requirements.
- .4 Submit sample paint colour chits or swatches for product as noted.
- .5 Include touch-up paint matching finishes for each major equipment as noted.

2.03 EQUIPMENT ENCLOSURE DRIP SHIELDS AND WATER INGRESS PROTECTION

- .1 Provide drip shields for protection of surface-mounted equipment enclosures located in climate-controlled areas, from water spray and dripping of liquids. Features of shields:
 - .1 Factory constructed by respective equipment manufacturers.
 - .2 Constructed from non-combustible materials (sheet steel).
 - .3 Enamel painted to match equipment.
 - .4 Prior to painting, surfaces and edges filed or sanded smooth.
 - .5 Where not integrated with top side of enclosure, mechanically supported from equipment with structural steel rods or metal framing or other similar means by equipment manufacturer.
 - .6 Structural support finish painted to match shield.
- .2 Include detailed dimensions of drip shields, and methods of supporting as applicable, with equipment shop drawings.
- .3 Provide equipment with piping, conduit or cable entries sealed with gasketing or waterproof sealant, preventing water from entering enclosure. Unless otherwise noted, do not penetrate drip shields or tops of enclosures with cable or conduit entries.
- .4 Provide enclosure ventilation louvers to protect live components from exposure to water spray and dripping liquids.
- .5 Above requirements are additional minimum "sprinkler protection" standards for equipment noted as NEMA 1, NEMA 2 or NEMA 12.
- .6 Provide NEMA 4 rated enclosures in non-climate-controlled non-hazardous classified areas unless otherwise noted.
- .7 Obtain CSA certification where required by AHJ.

2.04 SLEEVES

- .1 Poured Concrete Construction:
 - .1 Galvanized sheet steel: Minimum No. 16 gauge galvanized steel with integral flange at one end to secure sleeve to formwork construction.
 - .2 Polyethylene: Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses. Use where permitted by AHJ.

- .3 Waterproof sleeves in new poured concrete construction: Schedule 40 waterproof mild galvanized steel pipe with welded-on square steel anchor and water stop plate at sleeve midpoint.
- .2 Masonry and Drywall Construction:
 - .1 Schedule 40 mild galvanized steel pipe.
 - .2 Class 4000 cast iron pipe.
- .3 Interlocking Link Type Mechanical Seals:
 - .1 Synthetic rubber construction.
 - .2 Provides sealing rated of annular space between conduits and sleeves.
 - .3 Protects from galvanic corrosion.
 - .4 Absorbs shocks, sound and vibration.
- .4 Refer to requirements of Division 03.

2.05 FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Refer to Division 07 for requirements for firestopping and smoke seal materials.
- .2 Coordinate responsibilities for materials and work with general trades.

2.06 FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Asbestos-free, elastomeric materials and intumescent materials, for installation in ULC designated firestopping and smoke seal systems. Tested, listed and labeled by ULC in accordance with following:
 - .1 ASTM C679.
 - .2 ASTM D6904.
 - .3 ASTM G21.
 - .4 CAN/ULC-S101.
 - .5 CAN/ULC-S102.
 - .6 CAN/ULC-S115.
- .2 System assemblies and materials provide positive fire, water and smoke seal, and fire-resistance rating (flame, hose stream and temperature) no less than fire-rating for surrounding construction.
- .3 Assembly Rating: As determined by CAN/ULC-S115 which is equal to time rating of construction joint assembly.
- .4 Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of 0 as determined by ASTM G21.
- .5 Exterior exposure applications rain and water resistance: Provide perimeter joint sealant tested in accordance with ASTM D6904 with less than 1 hour tack free time as tested in accordance with ASTM C679.
- .6 Materials are specifically ULC certified with designated reference number for its specific installation. As part of shop drawing submission, submit copies of firestopping drawings with ULC certificate and system number for each specific installation.
- .7 Materials and manufacturers are specifically approved for each application of penetrated surfaces, by FM Global and listed in FM Global Approval Guide. As part of shop drawing submission, submit copies of firestopping drawings with FM Global Approval Guide.

- .8 Materials are 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. Coordinate material requirements with trades supplying abutting areas of materials.
- .9 Provide pre-formed firestop devices for use with non-combustible and combustible raceways, conduit or cable bundles penetrating concrete floors or gypsum walls.
- .10 Provide sealants or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing.
- .11 For typical standard indoor applications for piping installations to seal openings up to 25 mm, provide pre-formed firestopping cable discs with features as follows:
 - .1 Approximate Density: 1.6 g/cm³.
 - .2 Mold and mildew resistant.
 - .3 Surface Burning Characteristics: Flame Spread: 0 and Smoke development: 5.
 - .4 Application Temperature: 0 to 40°C.
 - .5 Percent Fill: Up to 100% per tested system.
 - .6 Sound Transmission Classification: 62 (Relates to specific construction).
- .12 For typical standard indoor applications to seal openings up to 1800 mm x 900 mm, ready-to-use, provide intumescent flexible block as follows:
 - .1 For sealing single or multiple penetrations of openings.
 - .2 For temporary or permanent sealing of cables and cable tray penetrations.
 - .3 For temporary or permanent sealing of conduit penetrations.
 - .4 Halogen, asbestos, solvent free and smoke resistant.
 - .5 Operational immediately after installation.
 - .6 Application Temperature: 5°C to 40°C.
 - .7 Temperature Resistance: Minus 15°C to 60°C.
 - .8 Intumescent Activation: Approximately 200°C.
 - .9 Expansion Ratio (unrestricted): Up to 1:3.
 - .10 Surface Burning Characteristics: Flame Spread Index: 10 and Smoke Development Index: 15.
 - .11 Sound Transmission Classification: STC Rating: 52.
 - .12 Suitable for wet areas when applied with additional silicone coating in accordance with manufacturer directions.
- .13 Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .14 Supply products of single manufacturer for use on work of this Division.
- .15 Installer is manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.
- .16 Manufacturer authorized technician services:
 - .1 Onsite inspection and verification of each installation and application.
 - .2 Preparation of test report signed and verified by system installer authorized representative and manufacturer authorized technician.
 - .3 Submission of test report that lists each installation with test results and respective ULC certification and number.

- .17 Acceptable certification also includes certification by Underwriters Laboratories of Northbrook IL, using tests in accordance with CAN/ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".

2.07 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.

2.08 ACCESS DOORS

- .1 Refer to Division 08, for access doors requirements.
- .2 Coordinate responsibilities for doors and work with general trades.
- .3 Coordinate location of outlet boxes, junction boxes, pull boxes, and other concealed equipment requiring access, to minimize need for access doors. Determine size, quantity and location of access doors, for ease of access to installation.
- .4 Size access door to suit concealed work for which they are supplied and wherever possible they are to be of standard size for each application, but in any case, of minimum 300 mm x 300 mm for hand entry and 600 mm x 600 mm for body entry.
- .5 Access doors in fire rated ceilings, walls, partitions, and structures, are ULC listed and labeled and of rating to maintain fire separation integrity.
- .6 Identify coordinated locations of proposed access door locations on reflected ceiling plans and wall elevation drawings, and submit to Consultant.

2.09 ACCESS DOORS

- .1 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 are rust resistant steel door panels, with concealed hinges and positive locking and self-opening screwdriver operated lock. Wall type frames are suitable for wall installation and have integral keys for plaster walls. Doors in tile wall are stainless steel and in ceilings are suitable for plaster covering with only frame joint showing. Other doors are prime painted steel.
- .3 Size access door to suit concealed work for which they are supplied, and wherever possible are of standard size for all applications, but in any case, are minimum 300 mm x 300 mm for hand entry and 600 mm x 600 mm 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 are 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 include dish-shaped door and welded metal lath, ready-to-take plaster. Provide plastic grommet for door key access.
- .6 Other access doors are welded 12 gauge steel, flush type with concealed hinges, lock and anchor straps, complete with factory prime coat. Submit to Consultant, details of non-standard door construction details.
- .7 Access doors in fire-rated ceilings, walls, partitions, or structures, are ULC listed and labelled and of rating to maintain fire separation integrity.

- .8 Where access doors are located in surfaces where special finishes are required, they are recessed door type capable of accepting finish in which they are installed so as to maintain final building surface appearance throughout.

2.10 EQUIPMENT BACKBOARDS

- .1 Refer to Division 06 for rough carpentry and Division 09 for painting, and provide equipment backboards as specified.
- .2 Coordinate responsibilities and work with general trades.

2.11 EQUIPMENT BACKBOARDS

- .1 FSC (Forest Stewardship Council), G1S (good one side) construction grade fir plywood.
- .2 Containing no added urea formaldehyde.
- .3 Flame retardant prime coat painted on exposed surfaces.
- .4 Minimum 20 mm thick, and as sized on drawings.
- .5 Flame spread rating:
 - .1 In accordance with building code requirements.
 - .2 Typically, maximum flame spread 25, maximum smoke developed 25.

2.12 ESCUTCHEON PLATES

- .1 One-piece or split, for piping passing through ceilings, walls and floors, in exposed spaces.
- .2 Finishes:
 - .1 No. 4 finish, type 302 stainless steel.
 - .2 Chrome.
 - .3 Nickel plated brass.
- .3 With matching finished screws for attachment to building surface.
- .4 Sizing: Completely covers sleeve or building surface opening, and fits tightly around conduits.

2.13 SECURITY FASTENERS

- .1 Provide security fasteners for products preventing easy access to and easy disassembly.
- .2 Review requirements with Consultant.
- .3 Type:
 - .1 In accordance with ISO 10664.
 - .2 Tamper-resistant, corrosion-resistant, stainless steel security type hexalobular equivalent to Torx head with post in center of head that prevents standard Torx driver from being inserted.
 - .3 Uses specific driver matching heads.

2.14 MAINTENANCE MATERIALS AND SPARE PARTS

- .1 Supply maintenance materials and spare parts as specified in respective Sections.
- .2 Generally, include:

- .1 One set of packing for each pump.
- .2 One casing joint gasket for each size pump.
- .3 One head gasket set for each heat exchanger.
- .4 One glass for each gauge glass.
- .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set at Substantial Completion.
- .6 One set of spare parts required to service equipment as recommended by respective equipment/system manufacturers.
- .7 One set of special tools required to service equipment as recommended by manufacturers.
- .8 One commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.
- .9 Other items noted within sections of Specification.

2.15 ACCEPTABLE PRODUCT MANUFACTURERS/VENDORS

- .1 Waterproof Seal Materials for Pipe Sleeves and Core Drilled Openings in Exterior:
 - .1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316.
 - .2 The Metraflex Co. "MetraSeal" type ES.
- .2 Firestopping and Smoke Seal Materials:
 - .1 Hilti Canada.
 - .2 Specified Technologies.
 - .3 3M Canada.
 - .4 Tremco.
 - .5 A/D Fire Protection Systems.
 - .6 Nelson.
- .3 Waterproofing Seal Materials:
 - .1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;
 - .2 The Metraflex Co. "MetraSeal" type ES.
- .4 Access Doors:
 - .1 Acudor.
 - .2 BAUCO
 - .3 SMS.

3. Execution

3.01 EXAMINATION

- .1 Verification of Conditions:
 - .1 Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for respective product installation in accordance with manufacturer written instructions.
 - .2 Verify that conditions are acceptable for product installation in accordance with manufacturer written instructions and for work of respective Sections.

- .3 Field verify building and site dimensions prior to fabrication and installation of equipment or materials.
- .2 Inspect conditions visually onsite. When requested by Consultant, inspect in presence with Consultant.
- .3 Report to Consultant, conditions that hinder or obstruct installation work beyond intent of issued Documents.
- .4 Proceed with installation only after these conditions have been remedied, and reviewed with Consultant.

3.02 TEMPORARY SERVICES

- .1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to:
 - .1 Temporary electrical power.
 - .2 Lighting.
 - .3 Heating.
 - .4 Water.
 - .5 Exit pathways.
- .2 Confirm locations of exit pathways are as decided at discretion of Prime Contractor.
- .3 Provide services in accordance with requirements of building codes and AHJ.

3.03 PROVISIONS FOR SYSTEMS/EQUIPMENT USED DURING CONSTRUCTION

- .1 Do not use permanent building mechanical systems for temporary heating or cooling purposes during construction.
- .2 Permanent mechanical systems in building may be used for temporary heating or cooling during construction subject to following conditions:
 - .1 Each entire system is complete, pressure tested, cleaned, and flushed out.
 - .2 Specified water treatment system has been commissioned, and treatment is being continuously monitored.
 - .3 Building has been closed in and areas to be heated/ventilated, are clean and will not thereafter be subjected to dust-producing processes.
 - .4 There is no possibility of damage from any cause.
 - .5 Supply ventilation systems are protected by 60% filters, which are to be inspected daily, and changed every 2 weeks, or more frequently as required.
 - .6 Return air systems have approved construction filters over openings, inlets, and outlets.
 - .7 Systems are operated in accordance with manufacturer recommendations or instructions, and are monitored on regular and frequent basis.
 - .8 Warranties are not affected in any way.
 - .9 Regular preventive and other manufacturer recommended maintenance routines are performed.
 - .10 Before application for Certificate of Substantial Performance of the Work, each entire system is to be refurbished, cleaned internally and externally, restored to as-new condition, and filters in air systems replaced.
 - .11 Energy costs are to be paid by contractor.

- .3 Confirm with Consultant what equipment can be used during construction.
- .4 Any system or equipment that is specified to be provided under requirements of Documents and is required to be used during construction stages of work prior to issuing of Certificate of Substantial Performance of the Work, are to be provided with special interim maintenance and service to cover systems/equipment during time of use during construction period of project until project has been certified as substantially performed and such systems/equipment are turned over to Owner.
- .5 During this period of construction, such systems/equipment to not become property of Owner or be Owner responsibility for maintenance or service. Systems/equipment are to remain property of respective manufacturers/suppliers or Contractor, who are responsible for full maintenance and servicing of systems/equipment in order to maintain validity of warranties after turn over to Owner.

3.04 PHASING AND SCHEDULING OF WORK

- .1 Include for scheduling, co-ordination, and construction phasing suiting project as specified in Division 01, or as noted. Prior to start of Work, review phasing requirements with Consultant.
- .2 Perform phasing and scheduling of Work to maintain existing building operations.
- .3 Perform work within occupied spaces and work affecting surfaces adjacent to occupied spaces during and after regular business hours, as coordinated with Owner and reviewed with Consultant. For areas where spaces are used by Owner on a 24-hours basis or over various hours, coordinate hours of work with Owner on a regular basis, suiting Owner schedule. Execute work at times approved by Owner and reviewed with Consultant, so as not to inconvenience Owner occupation or in any way hinder Owner use of building.
- .4 Provide project partial occupancy permits as required throughout project. Provide for each partial permit, compliance certificates for systems.

3.05 LAYOUT AND COORDINATION OF WORK

- .1 Cooperate and coordinate with other Divisions as required for completion of the Work and avoiding interference with work by other Sections.
- .2 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings. Lay out work for execution of work.
- .3 Examine drawings verifying work can be performed without changes to building as noted on plans.
- .4 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. As coordinated prior to start of Work with each trade and reviewed with Consultant to suit specific project requirements, following is typical order of right of way for services:
 - .1 Piping requiring uniform pitch.
 - .2 Piping 100 mm diameter and larger.
 - .3 Large ducts (main runs).
 - .4 Cable tray and bus duct.
 - .5 Conduit 100 mm diameter and larger.
 - .6 Piping less than 100 mm diameter.
 - .7 Smaller branch ductwork.

- .8 Conduit less than 100 mm diameter.
- .5 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 benchmarks 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. Prior to proceeding with Work, notify Consultant where any invert, grade, or size is at variance with Contract Drawings.
- .6 Prepare plan and interference drawings of work for coordination with each trade. Prepare detailed section drawings of ceiling spaces, areas of shafts, rooms and ceilings which are highly congested and for which site workers could not solve construction coordination issues. Indicate on section drawings lateral and elevation dimensions of major services within spaces. These drawings propose solutions for trades affected. Submit drawings to Consultant.
- .7 Prepare and submit drawings showing sleeving, recessed and formed holes required in concrete for work. Prepare drawings in conjunction with other trades. Prepare drawings to scale sufficient showing necessary details. Submit for review using same procedures as specified for shop drawings.
- .8 Locate shut-off valves, balancing devices, air vents, equipment and similar products, particularly such products located above suspended ceilings, for easy access for servicing or removal. Relocate products which do not meet this location requirement to accessible location, at no additional cost.
- .9 Dimension sleeves, recesses and openings with respect to building elevations and established grid lines.
- .10 Coordinate structural work for support of products with requirements of Division 13 and Structural Consultant as applicable.
- .11 Coordinate concrete work such as housekeeping pads, sumps and bases, required for work, and including required dimensions, operating weight of equipment and location.
- .12 Coordinate depth and routing of excavation required for work, and requirements for bedding and backfill, in accordance with requirements of Division 31 as applicable.
- .13 Coordinate with, instruct and supervise those Divisions doing related work.
- .14 Supply measurements of equipment to other Divisions allowing for necessary openings in their work.
- .15 Prior to commencing work, review relevant shop drawings and product data of other Divisions where they affect work of this Section.
- .16 Refer to electrical drawings when coordinating connections for starters, variable frequency drives, motors, panels and other similar equipment.
- .17 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.

- .18 Where drawings indicate that acoustic tile ceiling is being suspended below structural ceiling, coordinate design of framework used to support suspended ceiling, diffusers, and other components that are mounted within or through ceiling. Unless otherwise noted, do not mount devices to suspended ceiling. Secure and mount to ceiling slab above. Seal ceiling openings to maintain required fire-rating.
- .19 Order products in timely manner meeting project-scheduling timelines. Failure to order products to allow manufacturers sufficient production or delivery time to meet project-scheduling timelines is unacceptable reason to request for use of other suppliers or substitutions.

3.06 INTERRUPTION TO AND SHUT-DOWN OF MECHANICAL SERVICES AND SYSTEMS

- .1 Coordinate shut-down and interruption to existing mechanical services or systems with Owner. Generally, shut-downs may be performed only between hours of 12:00 midnight Friday until 6:00 a.m. Monday morning. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein. Services for operation of existing non-renovated areas of building are to be maintained.
- .2 Upon award of Contract, submit list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform Owner and Consultant in writing minimum 7 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any service or system without such written consent. Shutdowns of some essential services may require additional advance notification time.
- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete work for which shut-down is required are available at site.
- .5 Prior to start of work, confirm methods of procedures with Owner and review with Consultant.
- .6 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of codes and AHJ.

3.07 GENERAL INSTALLATION REQUIREMENTS

- .1 Unless otherwise noted, comply with manufacturer instructions and recommendations, including product technical bulletins, data sheets and handling, storage and installation instructions. Conform also to Contract Documents and accepted shop drawings.
- .2 Prior to roughing-in of devices and equipment, review final installation locations with Consultant.
- .3 Provide tested operational mechanical systems in accordance with requirements of Specification.
- .4 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .5 Refer to drawings, details and schedules for additional requirements.

- .6 Install piping and ductwork generally in locations and routes noted, close to building structure. Install minimizing furring requirements and interference with other services or free space. Remove and replace equipment not installed in accordance with Specifications, Drawings or manufacturer recommendations. Install piping and ductwork in concealed spaces, unless otherwise noted.
- .7 Unless otherwise noted, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by area construction. Install services as high as possible to conserve headroom or ceiling space. Prior to installation of Work, notify Consultant where headroom or ceiling space appears to be inadequate.
- .8 Provide additional material for modifications as required to correct minor job conflicts.
- .9 Refer to Architectural drawings for construction details, with regards to roof supports, piping and duct penetrations through walls, roof and other building construction.
- .10 Coordinate with Division 26, provision of following requirements for equipment and systems:
 - .1 Required SCCR for equipment.
 - .2 Motor controls and motor starters.
 - .3 Power connections and protection.
 - .4 Disconnect switches with absence of voltage testers.
 - .5 Integrated monitoring points to BAS.
 - .6 Integrated monitoring signals from lighting control systems.
 - .7 Integrated monitoring points to fire alarm system as coordinated with work of Division 28.
 - .8 Integrated monitoring points to security systems as coordinated with work of Division 28.
 - .9 Other items as indicated on drawings and as specified.
- .11 For cutting, patching and core drilling work, refer to Section 23 05 05 - Selective Demolition for HVAC.

3.08 SERVICE AND MAINTENANCE ACCOMMODATION

- .1 Install equipment with access and service clearances around equipment, and with space for future equipment removal and replacement. Provide access and service space provisions around equipment in accordance with requirements of AHJ.
- .2 Install equipment such as valves, motors, traps, dampers and controls, in manner facilitating proper maintenance and ease of repair or replacement.
- .3 Locate flanges and unions in such manner that equipment can be removed and replaced without major pipe cutting and removal.
- .4 Build ductwork adjacent to equipment so that it does not interfere with maintenance or repair of equipment. If interference cannot be avoided design and build ductwork so that it can be readily removed or hinged out of way.
- .5 Provide oil level gauges, grease cups, lubrication fittings, and other products for servicing equipment. Provide extensions allowing for servicing outside of fan cabinets.
- .6 Provide adequate clear space for equipment designated as supplied by others and provide connections for such equipment. Prior to commencing work, prepare and submit detailed layouts for review with Consultant.

- .7 Leave clear, spaces reserved for equipment noted as future on drawings, allowing for future connections.
- .8 Provide maintenance platforms, safety rails, ladders, and other products, facilitating maintenance of equipment which is not readily and safely accessible by ladder or from floor.
- .9 Lifting Eyes and Hooks:
 - .1 Equip motors and components weighing over 68 kg with lifting eye or lug.
 - .2 Where equipment is not in banks, provide two-eye hooks above each piece of equipment.

3.09 GROUTING AND LEVELLING

- .1 Equipment with bed plates and flexible or solid couplings: Grout under full area of bedplate, with non-shrinking premixed grout in accordance with applicable requirements of Division 03 or Division 04 and suiting intended applications. After grout sets, remove wedges, shims and jack bolts, and fill spaces with grout.
- .2 Level equipment on rough bases using metal levelling wedges and properly sized pieces of steel plate or steel sections. Maximum allowable grout thickness is 25 mm.

3.10 EQUIPMENT LOADS

- .1 Supply equipment loads (self-weight, operating weight, concrete pad, and inertia pads) 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, confirm equipment loads, location, and method of support prior to fabrication of structural steel. Prior to construction, review locations of equipment with Consultant.

3.11 OPENINGS

- .1 Supply opening sizes and locations to Consultant, allowing 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 review 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, or voids created under scope of work of project, and verify that openings created under scope of work have been closed off, firestopped and smoke-sealed. Unless otherwise directed by Owner and reviewed with Consultant, do not leave any openings unprotected or unfinished overnight.

3.12 INSTALLATION OF SLEEVES

- .1 Where pipes pass through concrete or masonry surfaces, or through fire-rated assemblies, provide pipe sleeves of type as noted and suiting intended applications.
- .2 Prior to pouring of concrete, install sleeves.
- .3 Size sleeves for free passage of piping and protruding 50 mm.

- .4 Do not use plastic sleeves in fire-rated walls or floors.
- .5 Submit to concrete reinforcement detailer at proper time, drawings indicating required sleeves, recesses and formed openings in poured concrete work or masonry work. Dimension such drawings and relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.
- .6 Use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .7 Size sleeves to leave 13 mm clearance around pipes, or where pipe is insulated, 13 mm clearance around pipe insulation, and other material passing through openings. Pack and seal void between sleeves and pipes, pipe insulation and other material passing through opening, for length of sleeves with specified firestopping and sealing materials, and including.
 - .1 Firestopping and smoke seal materials: Fire-rated construction.
 - .2 Fire-retardant, waterproof non-hardening mastic: Foundation walls and below grade floors.
 - .3 Waterstop plate and synthetic rubber interlocking link type mechanical seals: Waterproof slabs or walls.
 - .4 Acoustic seals for openings: Partitions and floor slabs.
 - .5 Water-tight seals: Exterior walls, or walls in contact with moisture.
 - .6 Synthetic rubber interlocking link type mechanical seals: Sealing pipes through other walls, floors and casings.
- .8 Supply sleeves of water protecting type in following locations:
 - .1 Mechanical and fan room floor slabs, except where on grade.
 - .2 Slabs over mechanical, fan, electrical and telephone equipment rooms or closets.
 - .3 Floors equipped with waterproof membranes.
 - .4 Roof slabs.
 - .5 Waterproof walls.
- .9 Do not provide "Gang" type sleeving.
- .10 Sleeves for exposed work: Terminate both ends of sleeves flush with building surface. Install escutcheon plate to cover sleeve completely, except for sleeves in waterproof floors which are to terminate 100 mm above finished floor.
- .11 Where sleeves are provided in non-fire-rated construction for future pipes and ducts, cap and seal both ends of sleeved opening.
- .12 Where conduits or duct are removed from existing sleeves, cap and seal both ends of sleeved opening.
- .13 Coordinate below grade penetrations with waterproofing systems or with damp proofing systems.
- .14 Where core drilling of masonry and concrete are performed in lieu of installation of pipe sleeves: Grout smooth cavities in core-drilled hole, and subject to review with and recommendation for acceptance by Consultant.

3.13 PACKING AND SEALING CORE DRILLED PIPE OPENINGS

- .1 Pack and seal void between pipe opening and pipe or pipe insulation for length of opening as follows:

- .1 Non-fire-rated interior construction: Pack with mineral wool and seal both ends of opening with non-hardening silicone base caulking compound producing water-tight seal.
- .2 Exterior walls above grade: Pack with mineral wool and seal both ends of sleeves water-tight with non-hardening silicone base caulking compound unless mechanical type seals have been specified.
- .3 Exterior walls below grade (and any other wall where water leakage may be a problem): Seal with link type mechanical seals as specified.

3.14 FLASHING FOR MECHANICAL WORK PENETRATING ROOF

- .1 Perform flashing work including counter-flashing, for mechanical work penetrating or set in roof.
- .2 Perform flashing work in accordance with drawing details and Division 07.

3.15 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Where work penetrates or punctures fire-rated construction, coordinate provision of ULC certified, listed and labeled firestopping and smoke sealing packing material systems to seal openings and voids around and within raceway and providing continuity and integrity of fire separation is maintained.
- .2 Refer to Division 07 for additional installation requirements. Coordinate responsibilities of work with general trades.

3.16 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Where work penetrates or punctures fire rated construction, provide firestopping and smoke sealing packing material systems to seal openings and voids around and within raceway and to provide continuity and integrity of fire separation is maintained.
- .2 Install firestopping and smoke seal materials for each installation in accordance with specific ULC certification number and manufacturer instructions. Comply with building code requirements and obtain approvals from AHJ. Verify that openings through fire separations do not exceed maximum size wall opening, and maximum and minimum dimensions in accordance with respective ULC listings.
- .3 Verify that continuity and integrity of fire separation is maintained and conform to respective ULC listings.
- .4 Perform work as follows:
 - .1 In accordance with manufacturer installation instructions for each specific application.
 - .2 Clean areas and surfaces before materials are installed.
 - .3 Examine substrates, openings, voids, adjoining construction and conditions under which firestop and smoke seal system is installed. Verify compatibility of surfaces.
 - .4 Verify penetrating items are securely fixed and properly located with proper space allowance between penetrations and surfaces of openings.
 - .5 Prior to commencement of work, report unsuitable or unsatisfactory conditions to Consultant. Commencement of work means acceptance of conditions and surfaces.
 - .6 Mask where necessary avoiding spillage and over-coating onto adjoining surfaces. Remove stains on adjacent surfaces.

- .7 Prime substrates.
- .8 Provide temporary forming and remove only after materials have gained sufficient strength and after initial curing.
- .9 Tool or trowel exposed surfaces neat, smooth, and with consistent finish.
- .10 Remove excess compound promptly as work progresses and upon completion.
- .5 When work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies, notify Consultant. Prior to concealing or enclosing work, arrange for final inspection of work by AHJ. Make corrections.
- .6 On completion of firestopping and smoke sealing installation, submit manufacturer technician compliance certificate certifying firestopping and smoke sealing installation has been carried out to service penetrations and that installation has been performed in accordance with requirements of AHJ, ULC requirements and manufacturer instructions.
- .7 Where work requires removal of existing firestopping materials and replacement of firestopping materials after cabling changes have been made, verify that replacement material is same material and manufacturer of existing if any remains in place, or verify that existing material is removed before installation of replacement material.

3.17 INSTALLATION OF BACKBOARDS

- .1 Provide backboards for systems and equipment as noted.
- .2 Securely wall mount each backboard with proper fasteners, suiting wall construction.
- .3 Size backboards to sufficiently provide adequate terminal space for each system, plus 20% space for future additions. Provide back boards of dimensions where identified.
- .4 Coordinate installation of backboards for systems and equipment with work of Section 06 10 00 - Rough Carpentry and Section 09 23 51 - Interior Painting.

3.18 INSTALLATION OF ESCUTCHEON PLATES

- .1 Provide escutcheon plates suitably secured over exposed conduits passing through finished building surfaces. Finished building surface is surface with factory finish or that receives site applied finish.
- .2 Install one piece escutcheon plates unless piping has already been installed.
- .3 Install plates tight against building surface concerned, completely covering sleeves and openings. Where waterproof sleeves extend above floors, fit plate tightly around sleeve.
- .4 Review finishes with Consultant.
- .5 Unless otherwise noted:
 - .1 Polished stainless-steel plates in finished spaces.
 - .2 Chrome or paint finish on metal plates in unfinished spaces.

3.19 CONCRETE REQUIRED FOR MECHANICAL INSTALLATION

- .1 Coordinate provision of concrete required for mechanical equipment pads with Work of Division 03. Coordinate requirements (type, dimensions, re-enforcing, locations).
- .2 Layout and mark out Work as required for installation of concrete necessary for equipment pads as indicated on drawings.

- .3 Locate pads at site and be present during concrete pour to ensure anchor bolts, inserts, plates and similar hardware are not damaged or dislodged.
- .4 Coordinate pad installations with concrete trade and ensure pads are keyed into structure to meet seismic restraint requirements.

3.20 CONCRETE WORK FOR MECHANICAL EQUIPMENT PADS

- .1 Provide poured concrete work, including reinforcing and formwork, required for mechanical equipment pads.
- .2 Perform concrete work in accordance with requirements of Division 03. Coordinate work with General Trades Contractor.
- .3 Concrete: Minimum 20,700 kPa ready-mix concrete in accordance with CSA A23.1, CSA A23.2 and building code.
- .4 Submit for review, dimensioned shop drawings, prepared and stamped by Structural Professional Engineer registered in jurisdiction of the Work, for concrete pads for support of equipment. Indicate on shop drawings total weight of pad as well as equipment it is provided for, and concrete reinforcing.
- .5 Verify that pads are keyed into structure in accordance with seismic restraint requirements.

3.21 EQUIPMENT BASES AND SUPPORTS

- .1 Provide equipment bases (pads) and supports. Coordinate concrete pour for pads with trades responsible for concrete pour.
- .2 Submit dimensioned shop drawings of structurally designed pads for support of large, heavy equipment. Indicate on shop drawings:
 - .1 Total weight of pad, reinforcement, and equipment for which it is required.
 - .2 Templates and anchor bolts for proper setting of equipment on pads.
- .3 Unless otherwise noted, submit detailed design of concrete pads.
- .4 Unless otherwise noted, secure floor-mounted equipment in place on concrete pads as follows:
 - .1 Pads not less than 100 mm high and not less than 200 mm clear of equipment on each side and end, or not less than 200 mm from centreline of equipment anchor bolts to edge of pad, whichever is larger.
 - .2 Secure equipment to pads with mounting hardware. Place anchor bolts during concrete pour and level, align and grout equipment.
 - .3 As minimum, use wire mesh reinforcement, however, for pads for large heavy equipment, use reinforcement in accordance with structural drawing details.
 - .4 Chamfer edges of pads.
 - .5 In accordance with equipment manufacturer recommendations and special construction requirements when specified by Structural Professional Engineer.
 - .6 Provide vibration isolation and seismic controls in accordance with respective product Sections or Section 23 05 48 - Vibration and Seismic Control.
- .5 Perform work within formwork Subcontractor schedule.
- .6 For equipment not designed for concrete base mounting and except those for small equipment, where required provide welded, cleaned and prime coat painted structural steel stands or supports in accordance with following:

- .1 Designed by Structural Professional Engineer registered in jurisdiction of the Work.
- .2 Submit stamped and signed design drawings with calculations as shop drawings for review.
- .3 Provide flange bolt steel stands to concrete pads.
- .4 Seismically restrained in accordance with AHJ and building code requirements.
- .7 Refer to Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment for additional requirements.

3.22 ELECTRIC MOTORS, MOTOR CONTROLLERS, CONTROLS AND ELECTRICAL CONNECTIONS

- .1 Coordinate responsibilities related to supply, installation, testing and verification of motors, motor control equipment (starters, motor control centres, variable frequency drives) and controls.
- .2 Control Wiring and Conduit: In accordance with Section 26 05 21 - Low Voltage Conductors and Cables, except for wiring and connections below 50 V which are related to control systems specified in Division 25.
- .3 Coordinate with Electrical Division 26, supply and installation of motor control centres (MCCs), motor starters, variable frequency drives (VFDs) (also known as variable speed drives –VSDs) and harmonic filters for motorized equipment supplied by Mechanical Divisions. Motor starters, MCCs and VFDs are generally as scheduled. Generally, starters are supplied in following manner:
 - .1 In accordance with respective product Sections and schedules. Provide controllers for each item of motorized equipment as scheduled.
 - .2 Supply motor control centres with starters and bolt to concrete pad.
 - .3 Package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from motor control centre: Provide disconnect switch in motor control centre in lieu of motor starter.
 - .4 3-phase starters mounted on motor starter panel: Mount and connect starters complete with panels and splitter trough as coordinated with Division 26 Electrical Work. Hand starters to electrical trade at site for installation.
 - .5 Package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from motor starter panel: Provide disconnect switch on motor starter panel as coordinated with Division 26 Electrical Work.
 - .6 1-phase motor starters: Unless otherwise noted, mounted adjacent to equipment they serve and connected complete as coordinated with Division 26 Electrical Work. Hand starters to electrical trade at site for installation.
- .4 Unless otherwise noted or coordinated with Electrical Division 26 Work, following electrical wiring work for mechanical equipment will be provided as part of Division 26 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 (VFDs), and load side power wiring from panels and VFDs to equipment.
- .4 Provision of receptacles for plug-in equipment.
- .5 Provision of disconnect switches in accordance with Section 26 28 23 - Disconnect Switches – Fused and Unfused.
- .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.
- .5 Wiring work not listed above or specified herein or on drawings as responsibility under electrical work: Provided under Mechanical Division Work in accordance with wiring and conduit requirements specified for Division 26 electrical work.
- .6 Refer to Section 26 05 80 - Motors for additional requirements.
- .7 Refer to Section 26 24 19 - Motor Control Centres for additional requirements.
- .8 Refer to Section 26 29 10 - Motor Starters to 600 V for additional requirements.

3.23 CLEANING

- .1 Progress Cleaning: Leave Work area clean at end of each day.
- .2 Final Cleaning:
 - .1 Perform following in mechanical equipment rooms:
 - .1 Prior to energization, HEPA vacuum and clean interiors of panels and cabinets, of construction debris and dust.
 - .2 HEPA vacuum top of panels and cabinets.
 - .2 Refer to individual sections for additional specific cleaning instructions.

3.24 SCAFFOLDING, HOISTING, AND RIGGING

- .1 Unless otherwise noted, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner and review with Consultant. Coordinate responsibilities and work with general trades.
- .2 Use scaffolds in manner with as little as possible interference to work of other trades.
- .3 Do not place major scaffolding or hoisting equipment loads on any portion of structure without approval from Owner and review with Consultant. Do not weld, bolt or otherwise affix supports, clips, brackets or similar devices to finished members or surfaces without approval from Owner and review with Consultant.
- .4 Immediately remove from site, scaffolding, rigging and hoisting equipment when no longer required.

3.25 PROTECTION

- .1 Protect equipment and materials onsite from damage and defacement due to elements and work of trades. Upon Substantial Performance of the Work, provide equipment and materials in new condition.
- .2 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.
- .3 Protect personnel on job site from injury due to live equipment and circuits.
- .4 Protect concrete floors and finished flooring from damage. Provide additional measures when moving heavy loads or equipment.
- .5 Keep floors free from oils, grease or other materials likely to discolour them or affect bond of applied surfaces.
- .6 Attach and fasten fixtures and fittings in place in safe, sturdy, secure manner so that they cannot work loose, fall or shift out of position during normal use of building.
- .7 Protect finished and unfinished work from damage due to carrying out of this work.
- .8 Make good damages caused directly or indirectly by work to walls, floors, ceilings, woodwork, masonry, finishes, structures and existing installations.
- .9 After products are installed and tested, protect products from dirt, dust and moisture until building is ready for turnover and service, unless otherwise noted.
- .10 Protect existing areas above, below and adjacent areas of Work from debris, noise, or interruptions to existing services in accordance with requirements of Owner and as specified. Maintain in operation existing services to these areas, allowing Owner continued use of these areas. Where services that are required to be maintained run through areas of renovations, provide protection to services or reroute, in coordination with Owner and review with Consultant.

3.26 FINISH PAINTING OF MECHANICAL WORK

- .1 Unless otherwise noted, finish painting of exposed Mechanical Divisions work is responsibility under work of Division 09.
- .2 Coordinate provision of identification painting for mechanical equipment in accordance with application requirements of Division 09. Review exact finish colours with Consultant. Equipment requiring special colour identification painting to include but not be limited to following:
 - .1 [].
- .3 Spray painting is not permitted unless approved by Owner and reviewed with and recommended for acceptance by Consultant.

3.27 COMMISSIONING

- .1 Commissioning Agent is appointed by Owner to oversee commissioning activities of contract.
- .2 Interface, cooperate and coordinate with Commissioning Agent and attend commissioning meetings. Perform commissioning activities for aspects of work provided in Mechanical Divisions and perform corrective work identified by Commissioning Agent.
- .3 After successful start-up and prior to Substantial Performance of the Work, commission mechanical work. Demonstrate to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that equipment, systems and subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents.

- .4 Verify modes and sequences of control and monitoring, interlocks, and responses to emergency conditions. Complete commissioning data sheets to document successful operational performance testing.
- .5 Make submittals such as O & M manuals, shop drawings, schedules and test reports of systems and equipment to Commissioning Agent, prior to start of commissioning activity or as directed by Commissioning Agent.
- .6 Commissioning Agent may also be present for any testing or commissioning activities. Notify Commissioning Agent in advance of these activities.
- .7 Coordinate work with Field Quality Control work.
- .8 Refer to Division 01 for additional commissioning requirements.
- .9 Refer to Section 23 08 00 - Commissioning of HVAC for additional requirements.

3.28 NOTICE FOR REQUIRED FIELD REVIEWS

- .1 Whenever there is requirement for Consultant to perform field review prior to concealment of any work, to inspect/re-inspect work, give minimum 7 working days' notice in writing to Consultant.
- .2 If Consultant is unable to attend field review when requested, arrange alternative date and time.
- .3 Do not conceal work until Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

3.29 MAINTENANCE OF EQUIPMENT PRIOR TO ACCEPTANCE

- .1 Provide maintenance to equipment in accordance with manufacturer instructions prior to start-up, testing and commissioning.
- .2 Employ qualified millwright to check and align shafts, drives, and couplings on base mounted split coupled motor driven equipment.
- .3 Where equipment lubrication fittings are not easily accessible, extend fittings to accessible locations using copper or aluminium tubing.
- .4 Filters to be new upon Substantial Performance of the Work. This is in addition to spare filters.

3.30 PRELIMINARY TESTING

- .1 When directed by Consultant, arrange, pay for and perform site tests on equipment or systems for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and AHJ requirements.
- .2 When, in Consultant opinion, tests are required to be performed by 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 or workmanship of any kind.
- .4 When, in Consultant opinion, tests indicate that equipment or products are defective or deficient, immediately remove such equipment or products from site and replace them with acceptable equipment or products, at no additional cost.

3.31 INTEGRATED SYSTEMS TESTING OF FIRE PROTECTION AND LIFE SAFETY SYSTEMS

- .1 Engage Integrated Testing Coordinator to prepare and execute Integrated Testing Plan, oversee integrated testing onsite and provide requirements in accordance with CAN/ULC-S1001 and AHJ.
- .2 Prepare and coordinate Integrated Testing Plan prior to start of verification work.
- .3 Include for but not be limited to full review, testing and verification of operation of integrated systems such as fire suppression systems, life safety systems, elevators and their emergency sequence of operation, HVAC equipment, supervisory annunciation of sprinkler/standpipe monitor switches, pressure switches and flow switches, diesel genset alarms, security alarms, BAS alarms, release of door holders and electromagnetic locks, and other integrated components.
- .4 Coordinate requirements with trades responsible for integrated components and systems, and arrange trades to be present at time of testing, and verification and commissioning work.
- .5 Test and verify performance of each integrated piece of equipment and system as integral parts combined into functional system.
- .6 Modifications to Existing Systems: Test and and verify performance of each modified integrated piece of existing equipment and existing systems as integral parts combined into functional system. Existing equipment and systems not modified can be noted as not in scope of Work.
- .7 Arrange and make available parties including Integrated Testing Coordinator, witnesses and AHJ, as required for witnessing of testing.
- .8 Rectify deficient work, and work that failed testing and re-test and re-verify, until successful testing.
- .9 Document testing and results in report, signed by testing technician, and listing Integrated Testing Coordinator, witnesses and AHJ.

3.32 FIELD QUALITY CONTROL

- .1 Unless otherwise noted, provide minimum [10] working days advance notice to Consultant of inspection, testing or verification work.
- .2 After completion of installation, perform inspection, start-up, testing and verification work in accordance with requirements of following:
 - .1 As specified in respective Sections.
 - .2 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .3 Section 23 08 13 - Performance Verification HVAC Systems.
 - .4 Manufacturer instructions and recommendations.
 - .5 Commissioning Agent and commissioning sections.
- .3 Perform field quality control work in addition to requirements of standard factory testing of products as specified in respective Sections. Submit specified factory testing reports with shop drawings.
- .4 Product Manufacturer Instructions and Recommendations:
 - .1 Submit product manufacturer instruction procedures and recommendations for product onsite start-up, testing and verification.

- .2 Include performance standards for verification, testing parameters, pass/fail or go/no-go standards.
- .5 Engage respective systems or equipment vendors or trades to be onsite during field quality control work to perform adjustments or remedial work to correct issues identified by field quality control work.
- .6 Manufacturer Certified Technician Field Quality Control Work:
 - .1 Onsite services as applicable to respective products as specified in Sections include providing basic requirements as follows:
 - .1 Visual Inspection:
 - .1 Verify that shipping members have been removed.
 - .2 Verify that interiors are free of foreign materials, tools and dirt.
 - .3 Check for damage (dents, scratches, frame misalignment, damage to devices).
 - .4 Check doors for proper alignment and operation.
 - .2 Mechanical Inspection:
 - .1 Check power wiring connections for tightness.
 - .2 Check control wiring connections for tightness.
 - .3 Electrical Inspection:
 - .1 Check input for proper voltage.
 - .2 Check output for proper voltage.
 - .4 Startup and Basic Commissioning:
 - .1 Startup of equipment and systems, installation, check, adjust, balance and calibrate components and instruct operating personnel.
 - .2 Energize units and perform manufacturer recommended start-up and commissioning procedures.
 - .5 Instructions: Instruct operating personnel in operation, care and maintenance of systems, system equipment and components.
 - .2 Services provided for such period, and for as many onsite visits as necessary to put equipment in operation and train operating personnel on aspects of operation and maintenance.
 - .3 Signed report or compliance certificate supplied verifying compliance of Work in performance, handling, installing, applying, protecting and cleaning of products. Submit reports as noted.
 - .4 Product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer instructions.
 - .5 Initial inspection, start-up, programming, testing and verification work.
 - .6 Assistance to installers with specific instructions on installation of equipment and systems.
 - .7 Assistance during independent testing in accordance with respective trade Sections.
 - .8 Instructions to end users on operating and maintenance of equipment and systems.
 - .9 Coordination of and directing adjustments to and remedial of work in accordance with performance requirements, test and verification report results and testing and verification report comments.

- .10 Assistance in integrations between systems and equipment.
- .7 Onsite Inspection, Start-up, Testing, Commissioning and Verification Work:
 - .1 Prepare proposed schedule for onsite testing and verification work and submit to Consultant for review and recommendation for acceptance. Notify Consultant in writing at least [10] working days in advance of testing and verification work, unless otherwise noted.
 - .2 Inspect and test products for proper operation and performance meeting requirements of Specification, AHJ, Consultant and Commissioning Agent. Where testing procedures conflict, review with Consultant prior to proceeding with Work and obtain direction.
 - .3 Refer to trade Sections for additional testing requirements.
 - .4 Verify operations and performance.
 - .5 Perform manufacturer start-up and basic commissioning procedures. Obtain copies of equipment start-up procedures and report forms from each manufacturer.
 - .6 Perform testing and verification work in presence of Consultant and Commissioning Agent. Commissioning Agent and Consultant to have option to attend and witness testing. Review and coordinate administration.
 - .7 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of phase of project (as applicable)
 - .8 and project.
 - .9 Unless otherwise noted, perform testing as non-destructive.
 - .10 Perform work for following:
 - .1 Drainage Systems:
 - .1 Drainage pumps and controls.
 - .2 Interceptors and backflow preventers.
 - .2 Fire Protection Systems and Life Safety Systems:
 - .1 Sprinklers and standpipes.
 - .2 Fire suppression systems.
 - .3 Coordination and cooperation with fire alarm system testing procedures, smoke control systems and other such fan system control sequences.
 - .3 Water Systems:
 - .1 Pumps and controls.
 - .2 Water heaters.
 - .3 Piping Specialties: Backflow preventers, mixing valves, and similar components.
 - .4 Trap seal primer units.
 - .5 Plumbing fixtures.
 - .4 Air handling systems with equipment, ductwork, ductwork specialties, controls, and interlocks.
 - .5 Control components, and overall operation of controls in conjunction with operation of connected building systems.
 - .6 Special usage room controls with confirmation of proper operation of individual components, and proper operation of overall control system.
 - .7 Noise and vibration control equipment.

- .8 Integrated systems and equipment: Where noted or required by AHJ, perform integrated systems testing in accordance with CAN/ULC-S1001. Coordinate Work with other Divisions.
- .9 Other equipment and systems as indicated on drawings and as specified.
- .8 Pipe Testing:
 - .1 Piping System 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, Commissioning Agent where required, and AHJ where required. Give minimum 7 working days notice of tests 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 notice of cancellation to all who were scheduled to attend.
 - .2 Gravity Drainage and Vent Piping:
 - .1 Test piping in accordance with 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 smoke test if required by AHJ.
 - .3 Pumped Drainage Piping:
 - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for minimum of 2 hours.
 - .4 Domestic Water Piping:
 - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for minimum of 2 hours.
 - .5 Sprinkler System Piping:
 - .1 Test system piping in accordance with NFPA 13, and in accordance with requirements of AHJ.
 - .6 Standpipe System Piping:
 - .1 Test system piping in accordance with NFPA No. 14, and in accordance with requirements of AHJ.
 - .7 Pure Water Piping:
 - .1 When piping has been properly flushed and cleaned, test at 690 kPa for 2 hours with only distilled water or filtered dry compressed air.
 - .2 If distilled water is used, drain system when testing is complete.
 - .8 Natural Gas Piping:
 - .1 Test piping in accordance with CSA B149.1 and additional requirements of AHJ.
 - .2 After completion of verification test, locate tag stating results of verification test at point of entry of gas main into building, affixed to pipe in secure manner.
 - .3 Check piping joints and connections for leaks with water and soap solution while piping is under pressure.
 - .4
 - .9 Following requirements apply to all types of piping testing:

- .1 Flush piping clean and 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 particular system, increase test pressure by the hydrostatic head of 7 kPa for every 600 mm below 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 results obtained are recommended for acceptance by Consultant or Commissioning Agent.
 - .7 Where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions.
 - .8 Perform tests 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.
- .9 Remedial Work:
- .1 Adjust and provide corrective work meeting performance requirements and in accordance with requirements as outlined in testing and verification reports.
 - .2 Rectify deficiencies and malfunctioning equipment.
 - .3 Remove and replace equipment that cannot be repaired.
 - .4 Re-test and verify corrected work.
 - .5 Test and verify replacement products and work.
- .10 Reports:
- .1 Prepare testing and verification reports, documenting results, observations and recommendations, signed by testing technician and witnesses.
 - .2 Where specified, submit reports stamped and signed by Professional Engineer.
 - .3 Submitted with product manufacturer report where required.
 - .4 Submitted with compliance certificates where required.
 - .5 Unless otherwise noted, submit electronic pdf versions to Consultant.

3.33 TRAINING AND DEMONSTRATION

- .1 Responsibility: Systems and equipment manufacturer authorized representative.
- .2 Submit for review with Consultant:
 - .1 Proposed list of systems and equipment for training and demonstration.
 - .2 Proposed schedule of demonstration and training dates and times.
 - .3 Proposed use of equipment and systems for training and demonstration purposes.

- .3 Provide onsite sessions to train and demonstrate to end user designated personnel, aspects of operation and maintenance of equipment and systems. Unless otherwise noted, supply printed copies and electronic copies of training materials to each attendee. Obtain from Owner, list of Owner representatives to receive instructions.
- .4 Provide dedicated separate sessions for each system, each with instruction duration time requirements to complexity of each system. 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 and audio-visual aids during training sessions. Supply required labour, material, and instruments.
- .5 Training modules consist of:
 - .1 Operational Requirements and Criteria: Equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations.
 - .2 Troubleshooting: Diagnostic instructions, testing and inspection procedures.
 - .3 Documentation: Equipment/system warranties, and manufacturer parts and service facilities, telephone numbers, email addresses and web sites.
 - .4 Maintenance: Inspection instructions, types of cleaning agents used as well as cleaning methods, preventive maintenance procedures and use of special tools.
 - .5 Repairs: Diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components and review of spare parts inventory.
 - .6 Other items as noted in Specification and items recommended by respective equipment manufacturers.
- .6 After training is completed, submit to Consultant, list of systems for which instructions were given, stating for each system:
 - .1 Date instructions were given to Owner staff.
 - .2 Duration of instruction.
 - .3 Names of persons instructed.
 - .4 Other parties present.
- .7 Obtain signatures of attendees to verify their attendance at these sessions and have received O&M instruction manuals.
- .8 Maintain record of training including:
 - .1 Topics covered.
 - .2 Dates and durations of sessions.
 - .3 List of attendees.
- .9 Submit to Consultant copy of electronic version of training materials loaded on USB flash drive. Include in operating and maintenance manuals submission.

3.34 SEMI-FINAL AND FINAL INSPECTIONS

- .1 Perform semi-final and final inspections with Consultant. Review scheduling requirements with Consultant and obtain Consultant recommendations for acceptance.
- .2 Semi-Final Inspections:
 - .1 Prior to semi-final inspection, submit list of items which are either not finished or deficient at time of semi-final inspection.

- .2 Verify following items prior to semi-final inspection. Provide declaration in writing that following items listed are completed:
 - .1 Systems capable of operation with controls functional and automatic controls generally in operation.
 - .2 Tests on equipment and systems made including tests required by AHJ.
 - .3 Equipment and system set-up and start-up procedures completed in accordance with manufacturer data.
 - .4 Equipment and system testing and identification completed.
 - .5 Valve tagging completed and equipment identified. Equipment and piping painted, and escutcheons installed.
 - .6 Equipment lubricated in accordance with manufacturer data.
 - .7 Warranty forms completed and registered with manufacturer. Include copies of original warranties with O & M manuals.
 - .8 Sample of O & M manuals submitted. Operating and maintenance instructions, and schedule submitted for Consultant review.
 - .9 Access doors inspected and verified in suitable location for easy access to equipment requiring maintenance and servicing.
 - .10 Equipment including plumbing cleanouts are easily accessible for maintenance and servicing.
 - .11 Noise and vibration control devices and flexible connections inspected by manufacturer representative and report submitted.
 - .12 Equipment alignment carried out by qualified millwright and certified report submitted.
 - .13 Fan plenums cleaned, temporary filters removed, and permanent filters installed.
- .3 Final Inspections:
 - .1 Submit to Consultant written request for final inspection of systems. Include written certification that:
 - .1 Deficiencies noted during job inspections and semi-final 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 Final calibration of controls completed.
 - .5 Maintenance and operating data have been completed and submitted to, reviewed with Consultant and accepted.
 - .6 Tags and nameplates are in place and equipment identifications have been completed.
 - .7 Clean-up is complete. Equipment cleaned inside, outside and lubricated. Plumbing fixtures and brass cleaned.
 - .8 Spare parts and replacement parts specified have been provided, as reviewed with Consultant.
 - .9 As-built and record drawings have been completed and submitted to and reviewed with Consultant and recommended for acceptance.
 - .10 End users have been instructed in operation and maintenance of systems.

- .11 Commissioning procedures have been completed and recommended for acceptance.
- .12 AHJ has accepted installations.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 National Research Council Canada (NRC):
 - .1 National Building Code of Canada (NBC), [2020].
 - .2 National Fire Code of Canada (NFC), [2020].
- .2 Ontario Building Code (OBC), [2012 with amendments].

1.02 REGULATORY REQUIREMENTS

- .1 Obtain permits and inspections and give required notices. Include copies of permits and inspection certificates with operation and maintenance manuals.
- .2 Perform work of this Section in accordance with following:
 - .1 NBC.
 - .2 NFC.
 - .3 OBC.
 - .4 Technical Safety and Standards Association (TSSA).
 - .5 Government of Canada, Labour Program: Workplace Safety.
 - .6 Ministry of the Environment, Conservation and Parks governing waste management.
 - .7 Ministry of Labour.
 - .8 AHJ.

2. Products

2.01 GENERAL

- .1 This section is common for demolition work of Divisions 21, 22 23 and 25.

2.02 MATERIALS

- .1 General Patching and Repair Materials: Refer to Division 02 for listing of patching and repair materials incidental to removal or demolition of components associated with work of this Section.
- .2 Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section. Provide new materials to meet assembly or system characteristics as existing systems indicated to remain and carry CSA certification labels.
- .3 Firestopping Repair Materials:
 - .1 Coordinate requirements with work of Section 07 84 10 - Comprehensive Firestopping.
 - .2 Use firestopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire-rated performance.

3. Execution

3.01 EXAMINATION AND SITE CONDITIONS

- .1 Discovery of Hazardous Substances: Refer to requirements in Section 23 00 10 - Mechanical Work General Instructions.
- .2 Refer to Section 02 41 19 - Selective Demolition for additional requirements.
- .3 Refer to Section 02 81 00 – Hazardous Materials for additional requirements.

3.02 SALVAGE AND DEBRIS MATERIALS

- .1 Review with Consultant, existing items designated as salvage, designated as reused or designated to be turned over to party designated by Consultant.
- .2 Coordinate performance of following with other trades:
 - .1 Removal from site and proper disposal of materials which are removed and are not designated for reuse in the Work.
 - .2 Removal of materials and items designated for salvage and storage in manner to prevent damage or devaluation of materials in accordance with Section 02 41 17 - Disassembly Removal and Storage.

3.03 PREPARATION FOR DEMOLITION WORK

- .1 Coordinate performance of following with other trades:
 - .1 Scheduling: Account for continued occupancy requirements during selective demolition in accordance with Section 02 41 19 - Selective Demolition.
 - .2 Verifying that affected building areas are unoccupied and discontinued in use and that required screens, partitions, hoardings are in place prior to start of demolition work.
 - .3 Prior to start of work, verifying that existing services in areas affected by demolition are disconnected, capped, made safe or removed as reviewed with Consultant.
 - .4 Prior to start of work, notifying Consultant and onsite personnel of demolition work that may cause safety risks.
 - .5 Coordinating electrical disconnections of electrically powered mechanical equipment and making safe electrical services with work of Division 26.
- .2 During course of building work, where asbestos-containing materials and/or other designated substances are encountered or suspected, cease work in area in question and immediately notify Consultant. Comply with authority having jurisdiction regulations. Do not resume work in affected area without direction from Consultant.

3.04 PROTECTION

- .1 Take steps to positively prevent uncontrolled falling of demolished materials.
- .2 Verify that no part of existing structure is over-loaded due to work carried out under Work.
- .3 Prevent debris from blocking surface drainage systems, elevators, mechanical and electrical systems that remain in operation. Provide temporary guards and hoardings during and until completion of work.
- .4 Coordinate performance of following with other trades:

- .1 Provision and maintenance of barricades, guards, railings, lighting, warning signs, security personnel and other safety measures for protection for workers and public during execution of the Work. Where demolition is proceeding, close off access to area to unauthorized personnel.
- .2 Provision of temporary bracing, shoring and supports as specified in Section 02 41 17 - Selective Structural Dismantling and Demolition and Section 02 03 46 - Shoring and Temporary Support.
- .5 In areas with retained services, maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of codes and AHJ.

3.05 MECHANICAL DISCONNECTIONS AND REMOVALS

- .1 Disconnect and remove items of existing obsolete mechanical, fire suppression and plumbing work, or work designated for removal, and miscellaneous appurtenances. Disconnect equipment at point of supply, drain piping, remove obsolete valves and piping up to source, and make system safe. Remove obsolete piping and ducts in exposed locations. Where existing obsolete piping and ducts are noted as abandoned and cannot be removed, such as embedded in concrete, cut back and cap unless otherwise noted. Refer to drawings for additional requirements.
- .2 When respective work is deleted, such deletions are not to affect operation of existing interconnected mechanical or electrical components that remain.
- .3 Refer to applicable architectural and mechanical drawings which define extent of areas being demolished in existing building. Review drawings and site and include for demolition and/or renovation of services as required to accommodate alterations detailed.
- .4 Where existing services pass through or are in area to serve items retained, or pass through areas being deleted, maintain services, but re-route as required. Reroute existing services concealed behind existing finishes and which are exposed during renovation work, and conceal behind new or existing finishes. Review with Consultant, services being kept in service and operational.
- .5 Protect existing devices being relocated or retained from damage. Prior to disconnection and de-energization, test retained devices, and verifying that each device is in proper working condition.
- .6 After installation is complete, test parts of re-used or relocated equipment. Engage manufacturer authorized representative or existing system maintenance contractor, to inspect and verify relocated devices. Perform testing and documenting to similar standards specified for new Work. Document testing in test reports, signed by testing technician. Submit copies to Consultant. Review requirements with Consultant.
- .7 Close openings that result from removal of equipment, piping, ducts, and such products. Close openings with covers plates and surface patching materials reviewed with Consultant, and properly terminate and seal to restore system to safe operating condition.
- .8 Where Work involves removal of existing process units which contain wastewater, grit, or sludge, remove entire contents and transport and dispose offsite.
- .9 Remove from site, existing materials that are disconnected and designated as obsolete or to be removed. Review such materials with Consultant. Transport materials being retained, to storage area designated by Consultant.
- .10 Arrange for disconnections of electrical power circuits feeding equipment being removed, with work of Division 26.

- .11 Include for workers that are licensed in their respective trades in place of Work, to perform respective work.
- .12 Prepare schedule of proposed shutdowns of existing services and submit to Consultant. Perform shutdowns as scheduled and as reviewed with Consultant.

3.06 CUTTING, PATCHING AND CORE DRILLING

- .1 Cutting and patching of existing building surfaces required for mechanical work, including core drilling walls and slabs for piping, is responsibility of another Division of the Work and is excluded from mechanical work.
- .2 Accurately and carefully mark out location and extent of cutting or drilling required and coordinate with trades performing work. Obtain Consultant approval of location and size of cut or drilled openings before work commences. Cut or drilled openings must not be larger than is absolutely necessary for installation of pipe, duct or similar materials and insulation where necessary.
- .3 Seal openings in fire-rated construction with firestopping and sealing as specified. Ensure openings are not left open overnight unless approved by Owner and reviewed with Consultant.

3.07 CUTTING, PATCHING AND CORE DRILLING

- .1 Perform cutting and core drilling of existing building required for installation of Mechanical Divisions of work. Perform cutting in neat and true fashion, with proper tools and equipment.
- .2 Prior to drilling or cutting openings, determine by review with Consultant and with use of non-destructive radar scan (magnetic scan) of slab or wall or surface, presence of existing services and reinforcement bars concealed behind building surface being cut. Locate openings to suit.
- .3 Criteria for cutting holes for additional services:
 - .1 Coordinate holes and chases required for work.
 - .2 Cut holes through slabs only. Do not cut holes through beams or girders.
 - .3 Cut holes 150 mm diameter or smaller only. Review with and obtain direction from Consultant (Structural Engineer) for larger holes.
 - .4 Core drill or saw cut opening of size leaving minimum 13 mm clearance around materials passing through opening.
 - .5 Keep at least 100 mm clear from beam faces.
 - .6 Space at least 3-hole diameters on centre.
 - .7 Holes closer than 25% of slab span from supporting beam face: Use cover meter above slab to clear slab top bars.
 - .8 Holes within 50% of slab span: Use cover meter underside of slab to clear slab bottom bars.
 - .9 Submit sleeving drawings indicating holes and their locations for Consultant (structural engineer) review.
 - .10 Prior to cutting or drilling structural elements, review with and obtain recommendations from Consultant.
- .4 Provide firestopping and sealing materials for packing and sealing void between opening and material passing through opening for length of opening.

- .5 Patch surfaces to match existing and adjoining surfaces, as reviewed with Consultant. Coordinate with work of general trades, suiting surface applications.

- .6 Refer to drawing notes.

3.08 PAINTING REPAIRS AND RESTORATION

- .1 Coordinate provision of painting and restoration work with work of Division 09.
- .2 Provide painting to match existing finishes as reviewed with Consultant.

3.09 DEMOLITION

- .1 Perform demolition of concrete, brick, timber, masonry structures, pole footings, equipment pads, and concrete poles, in manner and with equipment as not to disturb adjacent pavement, utilities, electrical equipment and other works remaining in position. Leave material designated as salvaged, in undamaged condition.
- .2 Demolish existing work to accommodate work.
- .3 Demolish work in a safe and systematic manner, from top to bottom.
- .4 Demolish in manner to minimize dusting. Keep dusty materials moist but prevent flooding or contaminated runoff.
- .5 Demolish masonry and concrete elements in small sections. Remove and lower structural framing and other heavy and large objects.
- .6 Leave work in safe condition, so that no part is in danger of uncontrolled toppling or falling.
- .7 Install temporary supports preventing uncontrolled collapse of structures.
- .8 Where partial removal of pavement, sidewalk, curb and gutter, or other structures is required for removal of equipment and results in broken edges of object remaining in place, square up and trim along straight lines at minimum distance of 300 mm from areas disturbed by removal operations. Remove for disposal, steel reinforcement, conduits, ducts, wires, and debris associated with removed portions of such structures.
- .9 Maintain adequate ventilation when using cutting torches.
- .10 Do not start any "Hot Works" without appropriate permits.
- .11 Do not overload floor or wall with accumulations of waste material or debris or by other loads.

3.10 DISPOSAL, CLEAN-UP, PATCHING AND MAKING GOOD

- .1 Package materials, rubbish, and debris resulting from demolition and remove from site and legally dispose.
- .2 Separate recyclable and reusable materials to maximum extent possible from general waste stream and place in recycling containers and bins. When full and Work is complete, remove recycling containers and bins from site and dispose of materials at appropriate authority having jurisdiction designated facilities.
- .3 Do not allow demolished materials to accumulate on site. As work progresses, remove and legally dispose of materials away from site.
- .4 Selling, burning or burying of materials on site is not permitted.
- .5 Leave work and storage areas in clean condition with required hoardings and guards in place.

- .6 Where existing surfaces are damaged by work or where existing devices are removed from wall, ceilings, floors and other surfaces, and such deleted devices are not being replaced in same locations, patch locations of these removed devices and re-finish. Where openings are left in existing ceiling tiles, replace ceiling tiles with new matching tiles. Include for:
- .1 Surfaces being filled and repainted: Clean, removing dirt, dust, oil, grease, loose paint, rust and other foreign matter which would prevent proper bonding of new finish.
 - .2 Sanding glossy surfaces to uniform dull texture.
 - .3 Filling-in and patching surfaces with same material as existing surfaces. Finish surfaces, matching and aligning with existing adjoining surfaces.
 - .4 Providing firestopping materials, maintaining fire-rating of existing surfaces.
 - .5 Using paint rollers or brushes to apply and extend paint finish over full height and width of area affected, to straight line in location reviewed with Consultant.
 - .6 Applying sufficient number of coats such that patched area is indistinguishable to surrounding area.
 - .7 Provide materials of equivalent quality to existing finishes standards and that are compatible with finishes to which they are applied.
 - .8 Prior to ordering, reviewing finishes with Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 National Research Council Canada (NRC):
 - .1 National Fire Code of Canada (NFC), [2020].

2. Products (Not Used)

3. Execution

3.01 CONNECTIONS TO EQUIPMENT

- .1 Make connections to equipment in accordance with manufacturer instructions, unless otherwise noted.
- .2 Provide valves and either unions or flanges suiting intended applications for isolation and ease of maintenance and assembly.
- .3 Connect piping to equipment using flexible connections or double swing joints suiting intended applications and as reviewed with Consultant when equipment mounted on vibration isolators and when piping is subject to movement.
- .4 Comply with additional requirements as noted on drawings or schedules.

3.02 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer, and complying with requirements in accordance with NFC.
- .2 Provide space for disassembly, removal of equipment and components as noted, as recommended by manufacturer, without interrupting operation of other systems, equipment and components.
- .3 Refer to additional clearance requirements as noted.

3.03 INSTALLATION OF DRAINS

- .1 Install piping with grade in direction of flow unless otherwise noted, and as reviewed with Consultant.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain. Terminate where discharge is visible.
- .4 Drain Valves: NPS 1/4 turn ball valves unless otherwise noted, with hose end male thread, cap and chain.

3.04 INSTALLATION OF AIR VENTS

- .1 Install air vents at high points in piping systems, and where noted.
- .2 Install isolating valve at each automatic air valve.

- .3 Install drain piping to location as noted and as reviewed with Consultant. Terminate where discharge is visible.

- .4 For air vents, refer to Section 23 21 16 - Hydronic Piping Specialties.

3.05 INSTALLATION OF DIELECTRIC COUPLINGS

- .1 General: Compatible with system, suiting pressure rating of system.
- .2 Locations: Where dissimilar metals are joined.
- .3 NPS 2 (50 mm) and Under: Isolating unions or bronze valves.
- .4 Over NPS 2 (50 mm): Isolating flanges.

3.06 INSTALLATION OF PIPING

- .1 Install pipework for systems and equipment.
- .2 Provide screwed fittings sealed with Teflon tape, pipe dope, or thread sealant compound.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework minimizing furring space, maximizing headroom, conserving space.
- .9 Install piping, unless otherwise noted, for positive drainage and air flow to go to vent.
- .10 Install, unless otherwise noted, permitting separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as noted.
- .12 Ream pipes and remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes, ensuring positive drainage and venting.
- .14 Provide for thermal expansion as noted and as required for intended applications.
- .15 For welding of piping, refer to Section 23 05 18 - Pipe Welding.
- .16 For additional requirements for hangers, supports, expansion fittings and other installation materials, refer to respective sections in this Division 23.

3.07 INSTALLATION OF VALVES

- .1 Install in accessible locations.
- .2 Before soldering, where required, remove parts to prevent damaging from overheating.
- .3 Install with stems above horizontal position unless otherwise noted and in accordance with manufacturer instructions.
- .4 Valves accessible for maintenance without removing adjacent piping.

- .5 Install globe valves in bypass around control valves.
- .6 Provide type of valves suitable for application and as noted, and at branch take-offs for isolating purposes, unless otherwise noted.
- .7 Install butterfly valves on chilled water and related condenser water systems only.
- .8 Install butterfly valves between weld neck flanges ensuring full compression of liner.
- .9 Install plug cocks and ball valves as required for glycol service.
- .10 Use chain operators on valves NPS 2 ½ (60 mm) and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .11 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow, and as noted.
 - .2 Install swing check valves in horizontal lines and on discharge of pumps and as noted.
- .12 Refer to additional requirements of Section 23 05 24 - Valves.

3.08 INSTALLATION OF SLEEVES

- .1 Provide sleeves in accordance with Section 23 00 15 Common Work Results for Mechanical.

3.09 INSTALLATION OF ESCUTCHEONS

- .1 Provide escutcheons in accordance with Section 23 00 15 Common Work Results for Mechanical.

3.10 PREPARATION FOR FIRESTOPPING

- .1 Coordinate installation of firestopping around pipes, insulation and adjacent fire separation in accordance with work of Section 07 84 10 - Comprehensive Firestopping.
- .2 Pipes Subject to Movement: In accordance with firestop system design listing ensuring pipe movement without damaging firestopping material or installation.
- .3 Insulated pipes: Verify integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush large piping systems in accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.
- .2 Before start-up, clean interior of small piping systems.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF PIPEWORK

- .1 Advise Consultant at least 10 working days prior to performance of pressure tests. Conduct tests in presence of Consultant.
- .2 Pework: Test as specified in relevant sections of heating, ventilating and air conditioning work. Refer to additional requirements of Section 23 08 13 - Performance Verification HVAC Systems.

- .3 Maintain specified test pressure without loss for 4 hours minimum, unless otherwise specified for longer period in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Provide repairs or replacement, retesting, and making good.
- .6 Insulate or conceal work only after review of work and recommendations for acceptance by Consultant.
- .7 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

3.13 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times reviewed and recommended by Consultant.
- .2 Request written recommendations for commencement of Work from Consultant, at least 10 working days prior to commencement of Work.
- .3 Where work of this project causes any damages to existing plant, provide remedial work.
- .4 Retest and verify remedied work.
- .5 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/Sheet Metal and Air Conditioning Contractors' National Association (ANSI/SMACNA):
 - .1 ANSI/SMACNA 016-[2012] HVAC Air Duct Leakage Test Manual.
- .2 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
 - .1 ASHRAE Handbook - HVAC Applications, Chapter 39 - Testing, Adjusting and Balancing, Chapter 48 - Noise and Vibration Control, [2019].
- .3 Associated Air Balance Council (AABC):
 - .1 AABC National Standards for Total System Balance, [7th Edition 2016].
- .4 National Environmental Balancing Bureau (NEBB):
 - .1 NEBB Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems [9th Edition, 2019].
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - .1 SMACNA HVAC Systems Testing, Adjusting and Balancing, [3rd Edition, 2002].

1.02 DEFINITIONS

- .1 "air systems": Includes outside air, supply air, return air, exhaust air, and relief air systems.
- .2 "branch main": Duct or pipe servicing 2 or more terminals.
- .3 "branch": Duct or pipe serving single terminal.
- .4 "flow rate tolerance": Allowable percentage variation, minus to plus, of actual flow rate values in Documents.
- .5 "hydronic systems": Includes heating water, chilled water, glycol-water solution, condenser water, and similar systems.
- .6 "main": Duct or pipe containing system's major or entire fluid flow.
- .7 "report forms": Test data sheets arranged for collecting test data in logical order for submission and review. Forms, when reviewed and accepted, to also form permanent record used as basis for required future testing, adjusting and balancing.
- .8 "submain": Duct or pipe containing part of systems capacity and serving 2 or more branch mains.
- .9 "TAB": Testing, adjusting and balancing to determine and verify quantitative performance of equipment and systems and to regulate specified fluid flow rate and air patterns at terminal equipment.
- .10 "terminal": Point where controlled fluid enters or leaves 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.

1.03 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets used in support of testing and balancing work.
 - .2 Include product ratings, performance criteria, physical size and limitations.
- .2 Submit certified testing and balancing reports as follows:
 - .1 Pre-TAB Review.
 - .2 Construction Review.
 - .3 Draft TAB.
 - .4 Final TAB.
 - .5 Post-Occupancy TAB.
- .3 Submit performance guaranty certificates.

1.04 QUALITY ASSURANCE

- .1 Engage independent testing, adjusting, and balancing (TAB) agency to perform testing, adjusting, and balancing of building mechanical systems and produce and verify design objectives. Agency is certified as independent agency in required categories by either AABC National Standards for Total System Balance or NEBB Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems.
- .2 Perform TAB work in accordance with:
 - .1 TAB Standard under which technician qualifications are approved. TAB Standards include:
 - .1 AABC National Standards for Total System Balance.
 - .2 ASHRAE Handbook - HVAC Applications, Chapter 39 - Testing, Adjusting and Balancing.
 - .3 NEBB Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems.
 - .4 SMACNA HVAC Systems Testing, Adjusting and Balancing.
 - .2 Recommendations and suggested practices contained in TAB Standard are mandatory.
 - .3 TAB Standard provisions, including checklists, and report forms meeting Specification requirements.
 - .4 TAB Standard for TAB, including qualifications for TAB agency and calibration of TAB instruments.
 - .5 TAB Standard quality assurance provisions such as performance guarantees certificates.
 - .6 Instrument manufacturer calibration recommendations when they are more stringent than those listed in TAB Standards.

1.05 CLOSEOUT SUBMITTALS

- .1 Final TAB Report:
 - .1 Format in accordance with AABC National Standards for Total System Balance or NEBB Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems.
 - .2 Identify in TAB reports, results in units consistent with project documents and include:

- .1 Project as-built drawings.
- .2 System schematics.
- .3 Requirements of Section 3.
- .3 Submit electronic PDF copy of TAB Report to Consultant.
- .2 Review submission requirements with Consultant.

2. Products (Not Used)

3. Execution

3.01 SCOPE OF WORK AND PURPOSE OF TAB

- .1 Test verifying proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.
- .2 Adjust and regulate equipment and systems, meeting specified performance requirements and achieving specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment, regulating flow rates to match load requirements over full operating ranges.
- .4 Perform total mechanical systems TAB work. Requirements include measurement and establishment of fluid quantities of mechanical systems meeting design specifications and comfort conditions, and recording and reporting results.
- .5 Perform pressure testing of ducts in accordance with Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .6 TAB following mechanical systems:
 - .1 Domestic water systems (piping extended from Municipal main) including:
 - .1 Domestic hot water recirculation piping.
 - .2 Tempered water piping flows.
 - .2 Air handling systems: Include equipment (RTUs, VAVs , Fans etc) and ductwork air temperatures, capacities and flows.

3.02 COORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule verifying completion before acceptance of project.
- .2 Perform TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems. Such interlocking work includes:
 - .1 HVAC equipment interlocking with fire alarm systems and other fire suppression systems as applicable.
 - .2 BAS interlocking with HVAC equipment and equipment and systems as noted.
 - .3 Work as noted.
- .3 Obtain copies of reviewed shop drawings of applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences.

3.03 PRE-TAB REVIEW AND REPORT

- .1 Prior to commencing TAB, complete following items and issue report to Consultant for review:
 - .1 Examine set of mechanical drawings with respect to routing of services and location of balancing devices and issue report listing results of evaluation.
 - .2 Submit set of drawings 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 Review with Consultant, adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB. Include recommendations within report.
 - .4 Review specified standards and identify in report, proposed procedures which vary from standard.
 - .5 Proposed Methodology: Submit proposed methodology and procedures for performing TAB when requirements are different from referenced standard.
 - .6 Include sample of draft TAB sheets. Include:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed.
 - .3 Calculations procedures.
 - .4 Summaries.
 - .7 Calibration of Testing Instruments:
 - .1 Submit to Consultant in Pre-TAB report, list of instruments used together with serial numbers.
 - .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
 - .3 Calibrate instruments within 1 month of any TAB readings.
 - .4 Prepare certificates of calibration identifying date of calibration for each instrument.

3.04 CONSTRUCTION REVIEWS

- .1 Visit site during construction of mechanical systems at regular intervals determined by review with Consultant and Commissioning Agent, observing routing of services, locations of TAB devices, equipment accessories, measurement ports and fittings, workmanship, and other factors affecting TAB.
- .2 After each site visit, report results of site visit indicating date and time of visit, and detailed recommendations for corrective work required for proper adjusting and balancing.

3.05 START-UP

- .1 Arrange for start-up procedures for equipment and systems. Coordinate responsibility for performing start-up procedures with TAB agency and manufacturers of equipment and systems.
- .2 Prior to start of TAB, perform start-up procedures as recommended by equipment manufacturer and as noted.
- .3 Perform special start-up procedures as noted.

3.06 OPERATION OF SYSTEMS DURING TAB

- .1 Operate systems for length-of-time required for TAB and as reviewed with Consultant.
- .2 Operate systems for length-of-time required for verification of TAB reports.
- .3 Maintain mechanical systems that are TAB, in full, normal operation during each day of TAB.

3.07 START OF TAB

- .1 Prior to start of TAB, notify Consultant, at least 10 working days.
- .2 Prior to commencing TAB, calibrate instruments and submit certificate of calibration.
- .3 Start TAB when building is essentially completed, including:
 - .1 Building construction work substantially complete.
 - .2 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .3 Application of weather-stripping, sealing, and caulking.
 - .4 Pressure, leakage, and other tests as noted.
 - .5 Provisions for TAB installed and operational.
 - .6 Mechanical systems are complete and checked, started, adjusted, and successfully performance tested.
 - .7 Building cleaned.
- .4 Subject to review with Consultant and Commissioning Agent, start TAB of system when system is complete, and area served by system is substantially complete.
- .5 Prior to TAB, walk each system from system "head end" equipment to terminal units to determine variations of installation from design. Include system installation trades along walk.
- .6 Prior to TAB, remove replaceable filters of equipment and install temporary substitute media having similar pressure drop. After TAB work is completed, remove temporary media and install back original new filters.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB, including:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air Systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, and ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors and panels, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .3 Liquid Systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.

- .5 Calibrated balancing valves installed, at factory settings.
- .6 Chemical treatment systems complete, operational.
- .8 Check valves and dampers for correct and locked position.
- .9 Check temperature control systems for completeness of installation before starting equipment.

3.08 TAB WORK PROCEDURES

- .1 Standards: TAB Standards in accordance with most stringent of this section.
- .2 Perform TAB of systems, equipment, components and controls as noted.
- .3 General:
 - .1 Air Systems:
 - .1 Include as appropriate for systems, equipment, components, and controls to measure:
 - .1 Air velocity, static pressure, flow rate, pressure drop (or loss).
 - .2 Temperatures (dry bulb, wet bulb, dewpoint).
 - .3 Duct cross-sectional area.
 - .4 RPM, electrical power, voltage.
 - .5 Noise and vibration.
 - .2 Locations of equipment measurements: Include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
 - .3 Locations of systems measurements: Include as appropriate:
 - .1 Main ducts.
 - .2 Main branch, sub-branch.
 - .3 Run-out (or grille, register or diffuser).
 - .2 Liquid Systems:
 - .1 TAB domestic water systems (piping extended from Municipal main) including:
 - .1 Domestic hot water recirculation piping.
 - .2 Tempered water piping flows.
 - .2 TAB of heating systems and cooling systems piping and equipment fluid temperatures, flows and control.
 - .3 Check:
 - .1 Systems are flushed, filled and vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place and baskets clean.
 - .4 Valves installed properly and set and calibrated at proper settings.
 - .5 Chemical treatment systems are in proper operation.
 - .3 Leak test ductwork in accordance with requirements of ANSI/SMACNA 016 and as noted. Coordinate work, provide detail identifying ductwork not in accordance with acceptable leakage values, and retest corrected ductwork.

- .4 Balance systems with regard to sound levels in ASHRAE Handbook - HVAC Applications, Chapter 48 - Noise and Vibration Control, when adjusting fan speeds and performing terminal work such as adjusting air quantities. Where sound levels exceed limits at design conditions, report problem and submit data, including sound readings, and make assessment of noise problem.
- .5 Check supply air handling system mixing plenums for stratification, and where variation of mixed air temperature across coils is in excess of $\pm 5\%$ of design requirements, report problem and issue detail sketch of plenum baffles required to eliminate stratification.
- .6 Perform TAB to within $\pm 5\%$ of design values, and make and record measurements which are within $\pm 2\%$ of actual values.
- .7 For air handling systems equipped with air filters, test and balance systems with simulated 50% loaded (dirty) filters by providing false pressure drop.
- .8 TAB 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 wet bulb temperature of maximum summer design condition, and within 5.5°C dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.
- .9 For belt-driven equipment, report to Consultant, situations where sheaves need replacement, suiting testing and balancing. Provide replacements.
- .10 After TAB is completed and reviewed with Consultant, replace drive guards, close access doors, lock devices in set positions, verify sensors are at required settings.
- .11 Permanently mark settings, allowing restoration during life of facility. Do not eradicate or cover markings.
- .4 Building Pressure Conditions:
 - .1 Adjust HVAC systems, equipment, controls, verifying specified pressure conditions at all times and during winter and summer design conditions.
- .5 Zone Pressure Differences:
 - .1 Adjust HVAC systems, equipment, controls, establishing specified air pressure differentials, with systems in every possible combination of normal operating modes.
- .6 Smoke Management Systems:
 - .1 Test for proper operation of smoke and fire dampers, sensors, detectors, installed as component parts of air systems specified.
 - .2 Emergency evacuation: Refer to post-occupancy TAB activities specified below.
- .7 Measurement of Vibration from Equipment:
 - .1 Review, inspect, and test equipment for performance of vibration isolators.

3.09 TAB REPORTS

- .1 Draft Report:
 - .1 Upon completion of TAB procedures, prepare draft reports on TAB standard forms. Organize and format draft reports in same manner specified for final reports. Submit copy of draft reports.
- .2 Final Report:

- .1 Upon verification and review of draft reports, prepare final reports, organized and formatted as specified below. Submit copies of final reports.
- .2 Use standard forms prepared by referenced standard for each respective item and system tested, adjusted, and balanced. Submit report forms complete with schematic systems diagrams and other data. Provide project identification and title descriptive of contents. Divide contents into divisions listed below:
 - .1 General Information and Summary.
 - .2 Air Systems.
 - .3 Hydronic Systems.
 - .4 Temperature Control Systems.
 - .5 Special Systems.
- .3 Provide following minimum information, forms and data in report:
 - .1 Inside cover sheet to identify party performing TAB work and Project, including addresses, and contact names and telephone numbers and listing of instrumentation used for procedures along with proof of calibration.
 - .2 Forms containing information indicated on standard TAB standard report forms prepared for each respective item and system.
 - .3 For each system being TAB, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories.
 - .4 Report sheets indicating building comfort test readings for rooms.
- .4 When final report has been reviewed and final recommendations made by Consultant, prepare and submit TAB Standard performance guaranty certificates.
- .3 Review submission requirements with Consultant and submit as directed.
- .4 Submit copies of reports signed by TAB technician.

3.10 VERIFICATION AND REMEDIAL WORK

- .1 After submission of final testing and balancing report, visit site with Consultant and Commissioning Agent to spot check results indicated on TAB report. Supply labour, ladders, and instruments to complete spot checks. When results of spot checks do not, on consistent basis, agree with final report, stop spot check procedures and rebalance systems involved. Resubmit final report, and again perform spot checks with Consultant.
- .2 Reported results subject to verification and review with Consultant and Commissioning Agent.
- .3 Provide personnel and instrumentation to verify up to 30 % of reported results.
- .4 Number and location of verified results: As reviewed with Consultant and Commissioning Agent.
- .5 Include for repeat of TAB as reviewed with Consultant and Commissioning Agent.
- .6 Where report results and findings result in performance not meeting Specification, perform remedial or replacement work until recommended for acceptance by Consultant and Commissioning Agent. Re-test to verify corrective measures have resolved problem areas.

3.11 POST-OCCUPANCY TAB

- .1 After acceptance of final report, perform post-occupancy TAB site visits in accordance with following requirements:
 - .1 Provide Post-occupancy TAB Visits:
 - .1 Once during first month of building operation.
 - .2 Once during third month of building operation.
 - .3 Once between fourth and tenth months in season opposite to first- and third-month visit.
 - .4 Once within 1 month of termination of Warranty Period.
- .2 Requirements of Each Return Visit:
 - .1 Schedule each visit suiting building maintenance manager schedule.
 - .2 Spot rebalance terminal units suiting building occupants and eliminate complaints.
 - .3 Measure air flow patterns, wet bulb temperature (WBT) (or % relative humidity), dry bulb temperature (DBT), air velocity, in occupied zone of indicated areas and areas reviewed with Consultant.
 - .4 After each follow-up site visit, issue to Consultant and Commissioning Agent, report indicating corrective work performed during visit, abnormal conditions and complaints encountered, and recommended corrective action.
- .3 Emergency Evacuation: Participate in full scale emergency evacuation exercises. As applicable, repeat smoke management tests.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/American Society of Heating, Refrigeration and Air Conditioning Engineers/Illuminating Engineers Society (ANSI/ASHRAE/IES):
 - .1 ANSI/ASHRAE/IES Standard 90.1-[2022] (SI Edition), Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American National Standards Institute/Sheet Metal and Air Conditioning Contractors' National Association (ANSI/SMACNA):
 - .1 ANSI/SMACNA 006-[2020], HVAC Duct Construction Standards - Metal and Flexible.
- .3 ASTM International (ASTM):
 - .1 ASTM A240/A240M-[22a], Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .2 ASTM B209/B209M-[21a], Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .3 ASTM C449-[07(2019)], Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C534/C534M-[20a], Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - .5 ASTM C553-[13(2019)], Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .6 ASTM C612-[14(2019)], Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .7 ASTM C892-[19], Standard Specification for High-Temperature Fiber Blanket Thermal Insulation.
 - .8 ASTM C1071-[16(2019)], Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .9 ASTM C1393-[19], Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks.
 - .10 ASTM C1423-[21], Standard Guide for Selecting Jacketing Materials for Thermal Insulation.
 - .11 ASTM E84-[21a], Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .12 ASTM E96/E96M-[21], Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
 - .13 ASTM G21-[15(2021)e1], Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .4 International Organization for Standardization (ISO):
 - .1 ISO 6944-1-[2008], Fire Containment - Elements of Building Construction - Part 1: Ventilation Ducts.
- .5 National Fire Protection Association (NFPA):

- .1 NFPA 96-[2021], Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .6 Midwest Insulation Contractors Association (MICA):
 - .1 NACIIS Manual-[9th Edition], North American Commercial and Industrial Insulation Standards Manual
- .7 Thermal Insulation Association of Canada (TIAC).
- .8 Underwriters Laboratories (UL):
 - .1 UL Directory C:
 - .1 UL Fire Resistance Directory (FRD), [2011].
- .9 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-[2018-REV1], Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S115-[2023], Standard Method of Fire Tests of Firestop Systems.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Include identification that product has also been tested to CAN/ULC-S102.
 - .4 Submit fire-rated duct wrap UL Fire Resistance Directory (FRD) ratings number documentation.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Where custom made removable/reusable covers for items such as plate type heat exchangers and 100 mm diameter and larger strainers, submit fabrication drawings indicating material and fabrication details, and 300 mm square sample of proposed cover material.
 - .3 Where fire-rated duct wrap is provided, submit letter from supplier certifying duct wrap has been properly installed.
 - .4 Where coloured lagging adhesive for canvas jacketed insulation is provided, submit colour chart.
- .3 Samples:
 - .1 At least [4] weeks prior to insulation work commencing, submit for review sample of each provided type of removable/reuseable cover, and insulation (and insulation accessories and finish) in applied form,.
 - .2 Mount samples on 12 mm thick plywood board. Identify each product with manufacturer name and insulation type, and proposed use of insulation.
 - .3 When samples have been reviewed by and with recommendations made by Consultant, provide mechanical insulation in accordance with Consultant reviewed samples.
- .4 Manufacturer Instructions:

- .1 Submit copies of manufacturer insulation jointing recommendations and special handling criteria, installation sequence, cleaning procedures and safety warnings.

1.03 QUALITY ASSURANCE

- .1 Company performing mechanical insulation work to be member in good standing of TIAC.

2. Products

2.01 GENERAL FIRE AND SMOKE RATING

- .1 Unless otherwise noted, materials in accordance with CAN/ULC-S102 and:
 - .1 Maximum Flame Spread Rating: 25.
 - .2 Maximum Smoke Developed Rating: 50.

2.02 MINERAL FIBRE INSULATION

- .1 Mineral Fibre: Glass fibre, rock wool or slag wool, suiting intended applications.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature.
- .3 Mineral Fibre Blankets:
 - .1 ULC listed and labeled, blanket roll form insulation in accordance with ASTM C553, 24 kg/m³ density, 40 mm thick and k rating of 0.036 W/m°C.
 - .2 Lightweight fibreglass bonded with formaldehyde-free resin and with factory applied aluminium foil and kraft paper vapour barrier facing.
 - .3 Maximum Use Temperature: 121°C.
- .4 Semi-Rigid Mineral Fibre Boards:
 - .1 ULC listed and labeled, large diameter roll form insulation in accordance with ASTM C1393, 40.1 kg/m³ density and k rating of 0.035 W/m°C.
 - .2 Consisting of cut strips of high temperature, semi-rigid fibreglass insulation glued to aluminium foil and kraft paper vapour facing.
 - .3 Maximum Use Temperature: 454°C.
 - .4 Thickness as specified in Part 3.
- .5 Rigid Mineral Fibre Boards:
 - .1 ULC listed and labeled, pre-formed board in accordance with ASTM C612, Class 1, 48 kg/m³ density and k rating of 0.033 W/m°C.
 - .2 Rigid fibreglass insulation with factory applied reinforced aluminum foil and kraft paper vapour facing.
 - .3 Maximum Unfaced Temperature Limit: 232°C.
 - .4 Thickness as specified in Part 3.

2.03 FLEXIBLE FOAM ELASTOMERIC INSULATION

- .1 Features:
 - .1 Sheet form, CFC free, black, flexible, closed cell, self-adhering elastomeric nitrile rubber, thermal and acoustical insulation.
 - .2 In accordance with ASTM C534/C534M.

- .3 Thermal Conductivity: 0.035 W/mK (up to 25 mm thickness).
- .4 Water vapour permeability rating of 0.08 Perm-in, in accordance with ASTM E96/E96M Procedure A.
- .5 Flame Spread and Smoke Developed Index: 25/50 rated in accordance with CAN/ULC-S102.
- .6 Service Temperature: Minus 34°C to 82°C.
- .7 Latex based, UV resistant protective coating for outdoor applications.

2.04 FIRE-RATED DUCT WRAP

- .1 Features:
 - .1 ULC listed and labeled, flexible, non-combustible, calcium-magnesium-silica fibre blanket duct wrap.
 - .2 In accordance with:
 - .1 ASTM C892.
 - .2 CAN/ULC-S102.
 - .3 CAN/ULC-S115.
 - .4 ISO 6944.
 - .5 NFPA 96.
 - .6 UL FRD.
 - .3 Completely encapsulated in fibreglass-reinforced aluminized polyester foil.
 - .4 Suitable for installation with zero clearance to combustibles (for grease ducts).
 - .5 Fire Ratings:
 - .1 2-hour fire resistance rating: 76 mm thickness.
 - .2 1 hour fire resistance rating: 38 mm thickness.
 - .3 Refer to Part 3 for additional thickness requirements.
 - .6 Flame Spread Index and Smoke Developed Index of bare blanket and of foil encapsulated blanket: 25/50.
 - .7 Wrap Density: Nominal 96 kg/m³.
 - .8 K rating at 982°C: 0.29 W/mK.
 - .9 Maximum Use Temperature: 1200°C.

2.05 INSULATION JACKETS AND FINISHES

- .1 Standards: In accordance with ASTM C1423.
- .2 Canvas:
 - .1 ULC listed and labeled, 25/50 fire/smoke rated, roll form.
 - .2 Minimum 220 gm/m² cotton, plain weave.
 - .3 Factory-treated with dilute fire-retardant lagging adhesive.
- .3 Flexible Insulation Jacketing:
 - .1 Flexible, laminated, self-adhering, protective PVC jacketing tape.
 - .2 Vapour barrier with 0.00 permeability rating and weatherproofing membrane, having high performance acrylic adhesive capable of installation with no additional mechanical attachment.
 - .3 Maximum flame spread/smoke developed rating of 25/50 when tested in accordance with CAN/ULC-S102.

- .4 Service Temperature Range: Minus 70°C to 148°C.
- .5 Before ordering, review finish colour requirements with Consultant.
- .4 Roll Form Sheet and Fitting Covers:
 - .1 From minimum size of 15 mm IPS cover with 0.4 mm white PVC jacket.
 - .2 Maximum 25/50 fire/smoke rated tested in accordance with CAN/ULC-S102.
 - .3 Complete with installation and sealing accessories.
 - .4 Before ordering, review finish colour requirements with Consultant.
- .5 Rigid Aluminium Jacketing:
 - .1 0.406 mm thick aluminum jacket material in accordance with ASTM B209/B209M.
 - .2 Finishes: Corrugated, smooth/flat or embossed, as noted or reviewed with Consultant.
 - .3 Factory cut to size.
 - .4 With factory-laminated moisture barrier consisting of:
 - .1 Engineered three-layer coextruded film of polyethylene and ionomer resin consisting of copolymer of ethylene and methacrylic acid polymers.
 - .2 Total film thickness of 0.08 mm.
 - .5 Continuous modified butt straps with straps to weatherproof end-to-end joints.
 - .6 2-piece epoxy coated pressed aluminum fittings with weather locking edges.
- .6 Stainless Steel Jacketing:
 - .1 0.254 mm thick type 304 embossed stainless steel jacket material in accordance with ASTM A240/A240M.
 - .2 Factory cut to size.
 - .3 With factory-laminated moisture barrier consisting of:
 - .1 Engineered three-layer coextruded film of polyethylene and ionomer resin consisting of copolymer of ethylene and methacrylic acid polymers.
 - .2 Total film thickness of 0.08 mm.
 - .4 Continuous modified butt straps with straps to weatherproof end-to-end joints.
 - .5 2-piece pressed stainless steel fittings with weather locking edges.
- .7 Adhesive-Backed Flexible Aluminium Jacketing:
 - .1 1.14 mm, prefabricated self-adhering, roll form sheet-type protective membrane.
 - .2 Outer layer consists of embossed, UV-resistant aluminum weathering surface.
 - .3 Under aluminum are multiple layers of high-density cross-linked polymer film.
 - .4 Under polymer film is uniform layer of rubberized asphalt adhesive.
 - .5 Self-adhesive surface protected by disposable release liner.

2.06 ACOUSTIC LINING

- .1 Features:
 - .1 Minimum 25 mm thick unless otherwise noted, acoustic lining material.
 - .2 Consisting of bonded fiberglass mat coated on inside (airside) face with black fire-resistant coating.
 - .3 In accordance with:

- .1 25/50 flame spread and smoke developed ratings tested in accordance with CAN/ULC S102.
- .2 NFPA 90A.
- .3 ASTM C1071 and ASTM G21.
- .4 Does not support microbial growth.
- .5 Flexible lining for round ducts, board type for rectangular ducts.

2.07 INSULATION FASTENINGS AND ACCESSORIES

- .1 Securing Calcium Silicate Duct Insulation in Place: Minimum 15 gauge galvanized annealed wire.
- .2 Securing Mineral Fibre Duct Insulation in Place:
 - .1 Weld-on 2 mm diameter zinc coated steel spindles of suitable length.
 - .2 Minimum 40 mm square plastic or zinc plated steel self-locking washers.
- .3 Securing Stainless Steel Insulation Jacket in Place:
 - .1 Type 304 stainless steel strapping banding with wing seals.
 - .2 Minimum 0.6 mm thick, minimum 12 mm wide.
- .4 Sealing and Securing Joints in Mineral Fibre Duct Insulation:
 - .1 High strength dead soft aluminum foil self-adhesive insulation tapes.
 - .2 Coated with cold weather acrylic pressure sensitive adhesive.
 - .3 Primary Liner: Polycoated Kraft.
 - .4 Operating Temperatures: Minus 40°C to 121°C.
 - .5 Tensile Strength: 36.8 N/100mm.
 - .6 Total Tape Thickness without Liner: 0.08 mm.
 - .7 Matching surface being sealed.
- .5 Adhering Board or Blanket Mineral Fibre Insulation:
 - .1 Mineral fibre insulation adhesive.
 - .2 Clear, pressure sensitive, brush consistency adhesive, suitable for temperature range of minus 20°C to 82°C.
 - .3 Compatible with type of material secured.
 - .4 Not identified as hazardous materials in manufacturer safety data sheets.
- .6 Securing and Finishing Canvas Jacket on Exposed Mineral Fibre Insulation:
 - .1 Lagging adhesive for canvas jacket fabric.
 - .2 White, brush consistency.
 - .3 ULC listed and labeled, maximum 25/50 fire/smoke rated in accordance with CAN/ULC-S102.
 - .4 Suitable for colour tinting.
 - .5 With fungicide.
 - .6 Washable when dry.
- .7 Flexible Elastomeric Insulation Adhesive:
 - .1 Air-drying contact adhesive.
 - .2 In accordance with ASTM E84.

- .8 Coating for Flexible Foam Elastomeric Insulation:
 - .1 White, weatherproof, water-based latex enamel.
 - .2 100% acrylic coating providing moisture-resistant protective finish.
- .9 Metal or Vinyl Corner Beads:
 - .1 Creates or conceals ductwork corner over insulated duct work when finishing with canvas and mastic materials.
- .10 Thermal Insulating Foamed Mastic:
 - .1 Thermally insulates hot and cold surfaces.
 - .2 Fire-resistant, non-toxic and remains semi-flexible after application.
 - .3 Continuous service temperature up to 88°C.
- .11 Vapour Retarder Lap Adhesive:
 - .1 Water based, fire-retardant type.
 - .2 Compatible with insulation.
- .12 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Paint-like coating that prevents condensation from forming on cold and dual temperature surfaces.
 - .3 Continuous service temperature at coated surface: 2°C to 114°C.
- .13 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Outdoor rated and UV resistant.
 - .3 Fire-resistant, non-toxic and remains semi-flexible after application.
 - .4 Continuous service temperature at coated surface: minus 29°C to 88°C.
 - .5 Reinforcing Fabric: Fibrous glass, untreated 305 g/m².
- .14 Insulating Cement:
 - .1 Hydraulic setting on mineral wool.
 - .2 In accordance with ASTM C449.
- .15 Contact Adhesive: Quick-setting.
- .16 Fasteners:
 - .1 4 mm diameter pins with 35 mm diameter clips.
 - .2 Length suiting thickness of insulation.
- .17 Screws: No. 10 stainless steel sheet metal screws.

2.08 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Blanket Mineral Fibre:
 - .1 Johns Manville, Microlite FSK Duct Wrap Type 150.
 - .2 Knauf Atmosphere, FSK Duct Wrap Type III.
 - .3 Manson, Alley Wrap FSK Duct Wrap Type III.
 - .4 CertainTeed SoftTouch FSK Duct Wrap Type 150.
 - .5 Owens Corning, SOFTR Duct Wrap.

- .2 Semi-Rigid Mineral Fibre Board:
 - .1 Johns Manville, Micro-Flex.
 - .2 Multi-Glass, Multi-Flex MF.
 - .3 Owens Corning.
- .3 Semi-Rigid Mineral Wool Blanket:
 - .1 Equal to Roxul Enerwrap, MA 960.
- .4 Rigid Mineral Fibre Board:
 - .1 Johns Manville, 800 Spin-Glas.
 - .2 Knauf, Earthwool.
 - .3 Manson, High Temperature Board.
- .5 Flexible Foam Elastomeric:
 - .1 Armacell, AP Armaflex.
 - .2 IK Insulation, K-Flex.
- .6 Fire-Rated Duct Wrap:
 - .1 3M, Fire Barrier Duct Wrap 615.
 - .2 CL4, CL4Fire RED.
 - .3 Unifrax, FyreWrap Elite 1.5.
 - .4 Morgan Advanced Materials, FireMaster FastWrap XL.
- .7 Acoustic Lining:
 - .1 Johns Manville.
 - .2 Manson Insulation.
 - .3 Knauf Insulation.
- .8 Insulation Fastenings and Accessories:
 - .1 As recommended by duct insulation manufacturers suiting installation requirements.
 - .2 Stainless Steel Banding:
 - .1 Equal to ITW Insulation Systems, Fabstaps.
 - .3 Tape Sealant:
 - .1 Equal to 3M, 1520-CW.
 - .4 Flexible Elastomeric Insulation Adhesive:
 - .1 Equal to Armacell, Armaflex 520.

3. Execution

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 References to concealed areas refer to mechanical services and equipment in suspended ceilings and non-accessible chases and furred -in spaces. References to exposed areas refer to areas exposed to normal view during normal conditions and operations and areas not referred as concealed.

- .2 Where insulation materials are stored onsite, store in dry storage areas reviewed with Consultant. Do not install wet insulation or insulation covered in moisture. Remove such insulation from site.
- .3 Unless otherwise noted, do not insulate following:
 - .1 Acoustically lined ductwork.
 - .2 Factory insulated flexible branch ductwork.
- .4 Prior to insulation installation, pressure test ductwork systems complete, witness and certify. Clean and dry surfaces, free from foreign material. Do not apply insulation unless leakage tests have been completed and results reviewed with and recommended for acceptance by Consultant.
- .5 Perform application of insulation when ambient temperature is minimum 13°C for at least one day prior to application work, and for duration of insulation work, and when relative humidity is at level where mildew will not form on insulation materials.
- .6 Install insulation in accordance with NACIIS Manual.
- .7 Apply materials in accordance with manufacturer instructions, unless otherwise noted.
- .8 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.
- .9 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.
- .10 Maintain uninterrupted continuity and integrity of vapour retarder jackets and finishes.
- .11 Unless otherwise noted, install hangers and supports outside of insulation and jackets.
- .12 Install fasteners at 300 mm on centre in horizontal and vertical directions, minimum two rows each side.
- .13 At fire dampers, install insulation tight to damper and fire separation assembly to ensure continuity of protection.
- .14 Refer to drawings/schedules for additional insulation requirements.

3.02 DUCTWORK INSULATION REQUIREMENTS – MINERAL FIBRE

- .1 Insulate following ductwork systems inside building or outside building above ground with mineral fibre insulation of thickness typically noted but revised suiting climate zones in accordance with ANSI/ASHRAE/IES Standard 90.1:
 - .1 Minimum 50 mm Thick:
 - .1 Outside air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections.
 - .2 When mixing plenums or sections are not provided, to first heating coil.
 - .3 When both mixing plenums or sections and heating coil sections are not provided, and fresh air is not tempered, then fresh air ductwork system complete.
 - .2 Minimum 25 mm thick rigid board or minimum 40 mm thick flexible blanket: Mixed supply air or preheated supply air casings, plenums and sections to and including fan section where not factory insulated.
 - .3 Minimum 25 mm thick rigid board or minimum 40 mm thick flexible blanket: Supply air ductwork outward from fans, except for supply ductwork exposed in area it serves.

- .4 Minimum 50 mm thick rigid board or minimum 40 mm thick flexible blanket: Exhaust discharge ductwork for distance of 3 m downstream (back) from exhaust openings to atmosphere, including exhaust plenums within 3 m distance.
- .5 Insulate other ductwork, casings, plenums or sections, with thickness as noted.
- .2 Provide rigid board type insulation for casings, plenums, and exposed rectangular ductwork. Provide blanket type insulation for concealed round, oval or rectangular ductwork. Provide semi-rigid mineral fibre board type insulation for exposed round or oval ducts.
- .3 Apply adhesive to surfaces of exposed rectangular ducts and casings. Accurately and neatly press insulation into adhesive with tightly fitted butt joints. Provide welded spindle/pin and washer insulation fasteners at 300 mm centres on bottom and side surfaces. Secure and seal joints with 75 mm wide tape sealant. At trapeze hanger locations, install insulation between duct and hanger.
- .4 Provide drywall type metal corner beads on edges of ductwork, casings and plenums in equipment rooms, service corridors, and other areas where insulation is subject to accidental damage as reviewed with Consultant, and secure in place with tape sealant.
- .5 Apply adhesive to surfaces of concealed rectangular or oval ductwork and wrap insulation around duct with top butt joint and tight section-to-section butt joints. Provide weld spindle and washer insulation fasteners at 300 mm centres on bottom surfaces. Secure and seal joints with 75 mm tape sealant. At each trapeze type duct hanger, provide 100 mm wide full-length piece of rigid mineral fibre board insulation between duct and hanger.
- .6 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 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 type insulation is used, provide 100 mm wide full circumference strip of semi-rigid board type duct insulation between duct and hanger.
- .7 Insulation application requirements common to 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 and with top strip to cover exposed edges of side strips, then butt 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 Install fastener spindles, pins and washers 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 jacket material, patch vapour barrier damage by means of tape sealant.

3.03 DUCTWORK INSULATION REQUIREMENTS – FLEXIBLE ELASTOMERIC

- .1 Prior to applying insulation, seal sheet metal work joints watertight.

- .2 Insulate exposed exterior ductwork (except fresh air intake ductwork) and associated plenums and casings outside building with minimum 50 mm thick flexible elastomeric sheet insulation, applied in minimum two 25 mm thick layers with staggered tightly butted joints.
- .3 Install with adhesive and coating in accordance with manufacturer instructions, producing weather-proof installation.

3.04 INSTALLATION OF FIRE-RATED DUCT WRAP

- .1 Provide blanket type fire-rated duct wrap system material for following ductwork to produce fire-rating noted:
 - .1 Kitchen exhaust ductwork from exhaust hood to masonry shaft: Two-hour rating in accordance with NFPA 96.
 - .2 Stairwell pressurization ductwork from fan to stairwell: One-hour rating in accordance with ISO 6944-1.
 - .3 Trauma Room and Operating Room supply and exhaust ductwork complete: 1 hour rating in accordance with ISO 6944.
 - .4 Wherever else noted or required: With rating matching building code requirements, unless otherwise noted.
- .2 Install duct wrap material in accordance with ULC design requirements and supplier/manufacturer instructions.
- .3 Coordinate installation of duct wrap with installation of ductwork.
- .4 Arrange for duct wrap supplier to examine and certify completed duct wrap system at site. Submit certification from supplier certifying duct wrap system is properly installed.

3.05 INSTALLATION OF ACOUSTIC LINING

- .1 Provide acoustic lining in ductwork:
 - .1 As noted.
 - .2 In supply ductwork downstream of air terminal boxes for distance of 2.4 m measured along duct and outward from box in all directions.
 - .3 In transfer air ducts.
- .2 Install lining in accordance with ANSI/SMACNA 006, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel in accordance with ANSI/SMACNA 006 detail entitled Flexible Duct Liner Installation.

3.06 INSULATION FINISH REQUIREMENTS

- .1 Canvas Jacket Material for exposed mineral fibre insulation:
 - .1 Unless otherwise noted, jacket exposed mineral fibre insulation work inside building with canvas secured in place with full covering coat of lagging adhesive.
 - .2 Cut canvas with sharp edge tools recommended by insulation manufacturer. Do not rip or tear canvas to size.
 - .3 Remove lagging adhesive splatter from adjacent uninsulated surfaces.
- .2 Flexible Insulation Jacketing:

- .1 Alternative to canvas and lagging, provide flexible insulation jacketing tape. Submit list with shop drawing submittal indicating which services are provided with flexible insulation jacketing.
- .2 For Installation Inside Building: Tested in accordance with CAN/ULC-S102 and in accordance with flame spread/smoke developed requirements.
- .3 Prior to ordering, review finishes and colours with Consultant.
- .3 Rigid Aluminum Jacketing:
 - .1 For services outside building, in non-climate-controlled areas.
 - .2 Install rigid aluminum jacket material tightly in place with overlapped circumferential joints positioned shedding water and covered with butt straps supplied with jacket.
 - .3 Insulate following:
 - .1 As noted on drawings.
 - .2 [].

3.07 FIELD QUALITY CONTROL

- .1 Inspect and verify product installations.
- .2 Arrange for fire-rated duct wrap supplier to inspect installation and submit certification of installation.
- .3 Verify types, ratings, finishes and sizing are in accordance with Specifications and applications.
- .4 Obtain compliance certificates and submit with reports.
- .5 Prepare inspection and verification reports, signed by technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 APPLICATION

- .1 This Section specifies commissioning requirements that are common to fire suppression work, plumbing work and mechanical HVAC work Sections and supplements to each Section.
- .2 This Section supplements requirements of Division 01.
- .3 Where requirements of this Section contradict requirements of Division 01, request for clarification from Consultant.

1.02 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - .1 ASHRAE Guideline 0-[2019], The Commissioning Process.
 - .2 ASHRAE Guideline 1.1, The HVAC Commissioning Process.
 - .3 ASHRAE Guideline 1.2, The Commissioning Process for Existing HVAC&R Systems.
 - .4 ASHRAE Guideline 1.5, Commissioning Smoke Control Systems.
 - .5 ANSI/ASHRAE/IES Standard 90.1-[2022] (SI Edition), Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group (CSA):
 - .1 CSA Z320-[11(R2021)], Building Commissioning.
- .3 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S1001-[2023], Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.03 DEFINITIONS

- .1 Commissioning: Process of demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, as further described below.
- .2 Commissioning Agent: Commissioning authority who supervises commissioning process and recommends final acceptance of commissioned electrical work.
- .3 Start-Up and Adjusting: Process of equipment manufacturer/supplier technical personnel, with respective Division Contractor, starting and operating equipment and systems, making adjustments, documenting process, and submitting manufacturer/supplier start-up reports confirming that equipment is properly installed and is operational as intended.
- .4 Pre-Functional Performance Testing: Testing, adjusting and operating of components, equipment, systems and subsystems, by respective Division Contractor, after start-up but before functional performance testing, confirming that components, equipment, systems and subsystems operate in accordance with requirements of Contract Documents, including modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets.

- .5 Functional Performance Testing: Repeat of successful pre-functional performance testing by respective Division Contractor, in presence of Commissioning Agent and Consultant with completed Commissioning Agent commissioning documentation sheets documenting, validating, and verifying that equipment, systems and subsystems are complete, function correctly, and are ready for acceptance.
- .6 Commissioning Documentation Sheets: Prepared sheets for pre-functional performance testing and for functional performance testing, supplied by Commissioning Agent for each piece of equipment and system commissioned. Each sheet or set of sheets are complete with Project name and number, date of commissioning, equipment or system involved, equipment or system name and model number, and equipment identification as identified on drawings. For each commissioning procedure listed, include on sheets, column giving expected data in accordance with Contract Documents, column to fill in observed data during commissioning, and space for signatures of respective Division Contractor and Commissioning Agent.
- .7 Systems Operating Manual: Manual prepared by Commissioning Agent, presenting overview of building electrical systems and equipment used by building maintenance personnel in assisting them in daily operation of systems.
- .8 Validate: Confirming by examination and witnessing tests, correctness of equipment and system operation.

1.04 COMMISSIONING AGENT

- .1 Retain services of third party qualified Commissioning Agent with following qualifications:
 - .1 Member of Professional Engineers Association in province of Place of Work.
 - .2 Member of Building Commissioning Association, and Certified Commissioning Professional (CCP) as designated by Building Commissioning Association.
 - .3 Minimum of five years of successful documented commissioning experience on projects of similar size and complexity as this Project.
 - .4 Professional Engineer and Building Commissioning Association Certified Commissioning Professional (CCP) or ASHRAE Commissioning Project Management Professional (CPMP) onsite supervision of commissioning process.
- .2 Involvement of Commissioning Agent performing duties as described in this Section is not in any way to void or alter contractual warranty obligations.
- .3 Commissioning Agent is retained and paid by Owner to perform mechanical work commissioning specified. Perform commissioning in accordance with requirements of Owner Commissioning Agent.

1.05 COMMISSIONING OBJECTIVES

- .1 Objectives of commissioning process:
 - .1 Support quality management by means of monitoring and checking installation.
 - .2 Verify equipment/system performance by means of commissioning of completed installations.
 - .3 Move completed equipment and systems from "static completion" state to "dynamic" operating state, and transferring complete and properly operating installation from Contractor to Owner and Consultant.
 - .4 Review requirements for integrated testing of life safety systems and confirm compliance with CAN/ULC -S1001.
- .2 Prerequisites to successful completion of commissioning:

- .1 Submittal of signed start-up and test reports.
- .2 Permanent electrical and control connections of equipment.
- .3 Successful completion and documentation of pre-functional performance testing.
- .4 Submittal of signed letters to Consultant, certifying that systems and subsystems have been started, tested, adjusted, successfully pre-functional performance tested, are ready for functional performance testing, and are in accordance with requirements of Contract Documents.

1.06 TESTING EQUIPMENT

- .1 Supply instruments and test equipment to conduct start-up, testing, verification and commissioning procedures.

1.07 SUBMITTALS

- .1 Submit to Commissioning Agent, at same time as submittal to Consultant:
 - .1 Copy of each shop drawing or product data sheet associated with equipment or systems being commissioned.
 - .2 Commissioning Plan with schedule, commissioning procedures for commissioning events, and Commissioning Agent commissioning data sheets for equipment and systems being commissioned.
 - .3 List of commissioning instruments and for each instrument, indicating purpose of instrument and including recent calibration certificate.
 - .4 Equipment and system manufacturer start-up and test report sheets (submit minimum of one month prior to equipment and system start-up procedures).
- .2 Final Commissioning Reports:
 - .1 After start-up and successful pre-functional performance testing and submittal of completed forms, submit for each system or subsystem, signed compliance certificate confirming that pre-functional performance testing is successfully completed and system or subsystem is ready for functional performance testing and commencement of commissioning process.
 - .2 Include copies of submittals listed above and completed testing forms.
 - .3 Submit verification that integrated systems are in compliance with CAN/ULC - S1001.
 - .4 Confirm format and submission requirements for reports with Commissioning Agent.

1.08 QUALITY ASSURANCE

- .1 Perform commissioning work in accordance with:
 - .1 Respective referenced standards.
 - .2 Documents of Commissioning Agent, as applicable.
 - .3 Division 01, as applicable.
 - .4 Specification Section requirements.
- .2 For systems such as building automation systems, fire protection systems, water treatment systems and similar systems with proprietary type operations and controls, include for engaging respective system manufacturer qualified technicians to assist in commissioning.

2. Products (Not Used)

3. Execution

3.01 PHASING OF COMMISSIONING

- .1 Perform commissioning in phases as noted. Phase commissioning work, suiting progress and phases of work.

3.02 DEFICIENCIES LISTED DURING COMMISSIONING

- .1 Within 15 calendar days of notification unless agreed otherwise with Consultant and Commissioning Agent, correct deficiencies listed by Consultant or Commissioning Agent during commissioning process.
- .2 When deficiencies have been corrected, notify Consultant and Commissioning Agent.

3.03 SYSTEMS TO BE COMMISSIONED

- .1 Commission systems as specified in Sections of Specification. Perform additional specific commissioning procedures as directed by Commissioning Agent. General commissioning procedures for typical equipment and systems include but are not limited to as listed below. Supplement with additional requirements of Commissioning Agent and AHJ.
- .2 Coordinate with commissioning of electrical systems and equipment.
- .3 Drainage Systems:
 - .1 Commissioning of drainage pumps and controls by means of tests recommended by manufacturer to confirm proper operation and performance.
 - .2 Commissioning of equipment such as interceptors and backflow preventers.
- .4 Fire Protection Systems:
 - .1 Commissioning in accordance with applicable NFPA Standards.
 - .2 Prepare and submit compliance and completion certificates required by NFPA Standards.
 - .3 Demonstration of proper system operation to governing AHJ, including Owner insurance underwriters.
 - .4 Coordination and cooperation with fire alarm system commissioning procedures, in particular smoke control systems and other such fan system control sequences.
- .5 Water Systems:
 - .1 Commissioning of water systems piping extended from Municipal mains.
 - .2 Commissioning of pumps and controls.
 - .3 Commissioning of water heaters.
 - .4 Commissioning of piping specialties such as backflow preventers, mixing valves, and similar components.
 - .5 Commissioning of trap seal primer units, including adjustment of water flows and confirmation of water flow at each connected trap.
 - .6 Commissioning of plumbing fixtures.
- .6 Natural Gas Systems:

- .1 Commissioning of pressure regulating equipment in accordance with requirements of Commissioning Agent and AHJ.
- .2 required system fine tuning.
- .7 Air Handling Systems:
 - .1 Commissioning of equipment, ductwork, ductwork specialties, controls and interlocks.
 - .2 Checking and validating air capacities and flows in accordance with TAB reports.
 - .3 Commissioning of controls for confirmation of proper operation of individual control components in accordance with control narratives, and overall operation of controls in conjunction with operation of connected building systems, including heating season/cooling season testing requirements specified above.
 - .4 Commissioning of special usage room controls includes confirmation of proper operation of individual components, and proper operation of overall control system, in accordance with governing Codes and Standards.
 - .5 Commissioning of noise and vibration control equipment includes noise and vibration measurements to confirm proper operation of equipment.
- .8 BMS/BAS:
 - .1 Commissioning of BMS/BAS for confirmation of proper operation of components, input/output points, hardware and software, and demonstration of system performing required procedures.

3.04 COMMISSIONING PROCESS

- .1 Perform commissioning process unless otherwise noted in Division 01, in stages and include, but not be limited to, following:
 - .1 Stage 1: Commission Work including equipment and systems as listed in this Section, which is a prerequisite to application for Substantial Performance of the Work and includes supervising and validating results of functional performance testing, and submittal of reviewed Systems Operating Manual.
 - .2 Stage 2: Commission Work 12 months after issue of Certificate of Substantial Performance of the Work and which includes supervision of Contractor "fine tuning" of equipment and systems through seasonal occupancy, and any other such work to achieve optimal comfort and performance conditions. Certificate of Total Performance of the Work is issued once Stage 2 is successfully completed.
 - .3 Stage 3: Successful completion of satisfactory equipment and system operation during first month after issue of Certificate of Total Performance of the Work.
 - .4 Stage 4: Successful completion of satisfactory equipment and system operation during third month after issue of Certificate of Total Performance of the Work.
 - .5 Stage 5: Successful seasonal commissioning of building.
- .2 Prerequisites to successful completion of commissioning:
 - .1 Submittal of signed start-up and test reports.
 - .2 Completion of system testing, adjusting and balancing (TAB), and acceptance of TAB reports.
 - .3 Permanent electrical and control connections of equipment.
 - .4 Successful completion and documentation of pre-functional performance testing.
 - .5 Successful completion and documentation of final performance testing.

- .6 Submittal of compliance certificates to Consultant certifying systems and subsystems have been started, tested, adjusted, successfully pre-functional performance tested, are ready for functional performance testing, and are in accordance with requirements of contract documents.

3.05 RESPONSIBILITIES OF COMMISSIONING AGENT (UNLESS OTHERWISE NOTED IN DIVISION 01)

- .1 The Commissioning agent will be an approved vendor selected from the City of Richmond Hill's roster and will be retained via a Cash Allowance. Commissioning Agent responsibilities during construction phase include:
 - .1 Review Contractor shop drawings for commissioning related issues and report such issues to Consultant.
 - .2 As soon as possible after project start-up, prepare and issue Commissioning Plan based on Contractor construction schedule.
 - .3 Prior to tests, supply to Contractor, pre-functional performance test commissioning data sheets for equipment and systems being commissioned.
 - .4 Monitor and inspect installation on regular basis throughout construction stages. Issue reports identifying issues which may have impact on commissioning process, and work with project team to expeditiously resolve problems that may arise due to site conditions.
 - .5 Arrange with Contractor for onsite commissioning meetings on as-required basis, attended by Contractor and applicable subcontractors and Consultant. Chair meetings and prepare and distribute meeting minutes to attendees.
 - .6 Witness and validate tests, identify deficiencies, and issue progress reports.
 - .7 Coordinate commissioning scheduling with Contractor.
 - .8 Review final TAB report on site with Contractor, and check 100% of TAB results for fan equipment, 30% of TAB results for duct systems outward from fan equipment, and issue report to Consultant.
 - .9 For smaller multiple items of equipment such as air terminal boxes, fan coil units, backflow preventers, and similar equipment, review completed commissioning data sheets submitted by Contractor and review data sheet information onsite with Contractor for 30% of quantity of each item of equipment.
 - .10 Review pre-functional performance test commissioning data sheets submitted by Contractor. Witness and supervise functional performance testing and supervise and direct commissioning process. Validate commissioning procedures, witness completion of commissioning data sheets by Contractor, and sign completed data sheets.
 - .11 Perform preliminary review of Contractor O & M Manuals, before issuing to Consultant, and issue comments to Consultant.
 - .12 Coordinate with Contractor and Consultant, training and instructions by Contractor and Contractor equipment and system manufacturers/suppliers to end user operating and maintenance personnel. Comment to Consultant, on quality of training and instructions.
 - .13 Prior to equipment and system training by Contractor, prepare and issue Systems Operation Manual to Consultant.
- .2 Commissioning Agent responsibilities during post-construction phase:
 - .1 Prepare and issue final report on commissioning, identifying deficiencies that remain outstanding.
 - .2 Recommend training and instructions given to end user operating and maintenance personnel, in addition to training and instructions already given.

- .3 After Substantial Performance of the Work, witness system checks and validate documentation by Contractor as follows:
 - .1 Once during first month of building operation.
 - .2 Once during third month of building operation.
 - .3 Once between fourth and tenth month of building operation but during a season opposite to first or third month visits.
- .4 Verify that deficient work resulting from system checks described above are corrected by Contractor.
- .5 3 months after Substantial Performance of the Work, attend question and answer sessions with Contractor, to answer questions and concerns related to commissioning work from end users operating personnel.

3.06 RESPONSIBILITIES OF CONTRACTOR

- .1 Contractor responsibilities during construction phase:
 - .1 Prepare and submit installation schedule that includes time schedule for each activity with lead and lag time allowed and indicated, shop drawing and working detail drawing submissions, and major equipment factory testing and delivery dates.
 - .2 Prepare and submit commissioning schedule that includes time schedule coordinated with installation schedule referred to above, and allowances for additional time for re-tests as may be required. Update schedule on monthly basis as required.
 - .3 When requested by Commissioning Agent, arrange site commissioning meetings with Consultant, and applicable subcontractors present. Meeting chaired by Commissioning Agent who also prepares and distributes meeting minutes.
 - .4 Correct reported deficient work, and report when corrective work is complete.
 - .5 Where required by codes, or Specification, retain equipment manufacturers/suppliers or independent third parties to certify correct installation of equipment and systems.
 - .6 Under supervision of equipment manufacturers/suppliers, start-up and adjust equipment to design requirements, and submit start-up sheets which include equipment data such as manufacturer and model number, serial number where applicable, and performance parameters, all signed by equipment manufacturer/supplier and Contractor.
 - .7 Complete Commissioning Agent commissioning data sheets for multiple items of smaller equipment such as air terminal boxes, fan coil units and backflow preventers. Submit sheets to Commissioning Agent and accompany Commissioning Agent for onsite check of 30% of data sheet information for each type of equipment. Perform corrective action as result of site checks.
 - .8 Perform system TAB, and when complete, issue copy of final report to Commissioning Agent for review and site check of results. Perform corrective work required as result of site checks by Commissioning Agent.
 - .9 In accordance with updated commissioning schedule and actual progress at site, certify in writing to Consultant and Commissioning Agent that equipment and systems are complete, have been checked, started and adjusted, successfully pre-functional performance tested and documented, and are ready for functional performance testing and commissioning procedures. Notify Consultant and Commissioning Agent minimum of 10 working days in advance.

- .10 Perform system and subsystem functional performance testing in presence of Commissioning Agent and under supervision of Commissioning Agent, and submit to Consultant and Commissioning Agent, completed and signed functional performance testing and commissioning data sheets (issued by Commissioning Agent) and also signed by Commissioning Agent.
- .2 Contractor responsibilities during post-construction phase:
 - .1 Optimize system operation in accordance with building occupant needs and comments using System Operation Manual prepared by Commissioning Agent as reference.
 - .2 Complete commissioning procedures, activities, and performance verification procedures that were delayed or not concluded during construction phase.
 - .3 Accompanied by Commissioning Agent, complete system checks and "fine tuning" with signed documentation as follows:
 - .1 Once during first month of building operation.
 - .2 Once during third month of building operation.
 - .3 Once between fourth and tenth month in a season opposite to first and third month visits.
 - .4 Correct deficiencies revealed by system checks described above, and, where required, involve equipment manufacturers/suppliers during corrective actions, and report completion of corrective work.
 - .5 3 months after Substantial Completion of the Work conduct question and answer sessions at building with end user operating and maintenance personnel, with duration of sessions dictated by number of questions and concerns that need addressing.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI):
 - .1 ANSI B109.1-[2019], Diaphragm -Type Gas Displacement Meters (Under 500 CFH Capacity).
 - .2 ANSI B109.2-[2020], Diaphragm-Type Meters (500 Cubic Feet per Hour Capacity and Over).
- .2 American National Standards Institute/American Society of Civil Engineers/Structural Engineering Institute (ANSI/ASCE/SEI):
 - .1 ANSI/ASCE/SEI 25-[2016], Earthquake Actuated Automatic Gas Shutoff Devices.
- .3 American Society of Mechanical Engineers (ASME):
 - .1 ASME B1.20.1-[2013(R2018)], Pipe Threads, General Purpose, Inch.
 - .2 ASME B16.5-[2020], Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 - .3 ASME B16.18-[2018], Cast Copper Alloy Solder Joint Pressure Fittings.
 - .4 ASME B16.22-[2018], Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - .5 ASME B18.2.1-[2012(R2021)], Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
 - .6 ASME BPVC-IX-[2023], BPVC Section IX - Welding, Brazing, and Fusing Qualifications.
- .4 ASTM International (ASTM):
 - .1 ASTM A47/A47M-[99(2022e1)], Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-[22], Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 ASTM A105/A105M-[21], Standard Specification for Carbon Steel Forgings for Piping Applications.
 - .4 ASTM B837-[19], Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .5 CSA Group (CSA):
 - .1 CSA B51-[24], Boiler, Pressure Vessel and Pressure Piping Code.
 - .2 CSA B137 Series Package-[23], Thermoplastic Pressure Piping Standards Package - Consists of all the CSA B137-20 Standards.
 - .3 CSA B149.1-[20], Natural Gas and Propane Installation Code.
- .6 Government of Ontario:
 - .1 O. Reg. 215/01-[2022], Fuel Industry Certificates.
- .7 Technical Standards and Safety Authority (TSSA) standards and regulations.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Submit for each gas pressure regulating station:
 - .1 Selection sheet for each pressure relief valve (PRV), indicating connected equipment, heating loads, design allowance, meter model, body size, spring range and orifice size.
 - .2 Selection sheet for each relief valve serving PRV.
 - .4 Submit manufacturer installation instructions.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit manufacturer technician compliance certificates certifying that materials comply with specified performance characteristics and physical properties and systems are installed in accordance with manufacturer guidelines.
- .4 Submit compliance certificates, and testing and verification reports.

1.03 QUALITY ASSURANCE

- .1 Gas system work: In accordance with CSA B149.1, as amended by AHJ.
- .2 Perform gas system work using licensed gas piping fitters authorized and certified in accordance with TSSA and O. Reg. 215/01, or local equivalent AHJ requirements.
- .3 Perform work in accordance with authority requirements. Include and arrange for AHJ review and approval process. Notify Consultant of AHJ advised revisions to meet AHJ approvals. Include for revisions to systems to obtain AHJ approvals.

1.04 PRE-INSTALLATION MEETING

- .1 Convene pre-installation meeting at least seven working days prior to beginning work of this Section, and as reviewed with Consultant.
- .2 Verify project requirements.
- .3 Review installation and substrate conditions.
- .4 Coordinate with other building subtrades.
- .5 Review manufacturer installation instructions and warranty requirements.

2. Products

2.01 PIPE, FITTINGS AND JOINTS

- .1 Above Ground Piping:
 - .1 Uncoated Black Steel - Screwed Joints:
 - .1 Schedule 40 mild black carbon steel, in accordance with ASTM A53/A53M, Grade B.
 - .2 Malleable cast iron screwed fittings in accordance with ASME B1.20.1, and screwed joints.

- .2 Uncoated Black Steel - Welded Joints:
 - .1 Schedule 40 mild black carbon steel, in accordance with ASTM A53/A53M, Grade B.
 - .2 Mill or site bevelled, complete with factory made forged steel butt welding fittings and welded joints.
- .3 Copper - Uncoated:
 - .1 Type "G" seamless copper tubing in accordance with ASTM B837.
 - .2 Hard temper with wrought copper capillary brazed joint type fittings in accordance with ASME B16.22.
 - .3 Brazed joints made with brazing alloy, or soft temper with flared brass fittings of single 45° flare type.
 - .4 Forged or with machined long nut and copper to copper threaded connectors.
 - .5 Where required, flared brass copper to NPS adapters.
- .4 Flexible Stainless Steel (alternative to copper or steel for equipment connections of 9.5 mm to 20 mm diameter piping):
 - .1 Flexible, CSA certified, 860 kPa rated.
 - .2 Gas-tight, convoluted stainless steel tubing factory jacketed with bright yellow PVC coating which is continuously identified.
 - .3 Supply tubing in coils and complete with factory attached stainless steel end fittings, and adapter unions, protective plates, and steel clamps.

2.02 JOINTING MATERIALS

- .1 Screwed Fittings: Pulverized lead paste.
- .2 Welded Fittings: In accordance with ASME BPVC-IX and CSA B51.
- .3 Flange Gaskets: Non-metallic flat.
- .4 Brazing: In accordance with ASTM B837.

2.03 FITTINGS AND UNIONS

- .1 Steel Pipes: Screwed, flanged or welded:
 - .1 Screwed Piping: Malleable iron, ground joint, bronze or brass to iron or bronze to bronze seat screwed unions and union elbows with minimum pressure rating of 1725 kPa steam at 260°C.
 - .2 Malleable Iron: Screwed, banded, Class 150.
 - .3 Steel pipe flanges and flanged fittings: In accordance with ASME B16.5.
 - .4 Flanged Piping: Forged carbon steel slip-on type raised faced welding flange unions in accordance with ASTM A105/A105M, 150 Class for steel pipe.
 - .5 Welding: Butt-welding fittings.
 - .6 Unions: Malleable iron, brass to iron, ground seat, in accordance with ASTM A47/A47M.
 - .7 Bolts and Nuts: In accordance with ASME B18.2.1.
 - .8 Nipples: Schedule 40, in accordance with ASTM A53/A53M.
- .2 Copper Pipes: Screwed, flanged or soldered:
 - .1 Flanges: Slip-on type 150 Class bronze flanges for copper pipe.

- .2 Cast Copper Fittings: In accordance with ASME B16.18.
- .3 Wrought Copper Fittings: In accordance with ASME B16.22.

2.04 VALVES

- .1 Shutoff Ball Type Valves (for 6 mm to 100 mm diameter inside or outside building):
 - .1 CSA certified, minimum 3100 kPa WOG rated.
 - .2 1/4 turn removable lever handle.
 - .3 Full port non-lubricated brass ball valves.
 - .4 Teflon PTFE seat, chrome plated solid ball, and screwed ends.
- .2 Shutoff Ball Type Valves (for 100 mm to 200 mm diameter inside or outside building):
 - .1 CSA certified, Class 150.
 - .2 1/4 turn removable lever handle.
 - .3 Full-port, cast iron body.
 - .4 Stainless steel ball and stem, Teflon PTFE seat.
 - .5 Flanged ends.
- .3 Seismic Activated:
 - .1 Flanged, high pressure automatic seismically activated shut-off valve suitable for both natural gas and propane.
 - .2 ULC listed and labeled and in accordance with ANSI/ASCE/SEI 25.
 - .3 No magnets used to attract debris and interfere with operation.
 - .4 No internal or external source of electrical power needed.
 - .5 Ball used for actuation and not for sealing of flow line.
 - .6 Manual reset.
 - .7 Pressure Ratings: 0.34 to 413 kPa.

2.05 PRESSURE REGULATORS

- .1 CSA certified pressure regulators as follows:
 - .1 Indoor use for connection to appliances such as gas fireplaces:
 - .1 Non-vented type.
 - .2 Lever action, dead end lockup type.
 - .3 Vent limiter, self-aligning valve, die-cast aluminium housing, and synthetic rubber compound diaphragm.
 - .2 Other applications as noted:
 - .1 Vented type of spring-loaded self-operated design.
 - .2 Tight closing, selected for facility gas pressure and piping pressure loss, and connected equipment load at full firing rate plus 20% spare.
 - .3 1035 kPa rated cast iron body finished with corrosive-resistant epoxy enamel.
 - .4 Aluminum diaphragm and spring case with nitrile diaphragm, disc, and body O-ring.
 - .5 Throttling type, high flow rate, tight shut-off relief valve selected to protect equipment downstream of regulator in coordination with regulator capacity.

2.06 NATURAL GAS CONVENIENCE OUTLETS

- .1 CSA certified outlet.
- .2 Ball valve typically for gas service connection for exterior building gas appliances where pressure is from 13 kPa to 34 kPa and temperature range from minus 40°C to 116°C.
- .3 Quick-connect type, with interlocking safety-cam preventing release of appliance connector until valve is off.
- .4 Integral thermal shut-off protection device preventing gas flow when outlet is exposed to temperatures exceeding 90°C.
- .5 Wall Enclosure Box:
 - .1 Recessed-in-wall or surface mounted as noted.
 - .2 Weather-resistant.
 - .3 Weathertight gasketed hinged lockable door.

2.07 NATURAL GAS CHECK METERS

- .1 Standard Diaphragm Gas Meters:
 - .1 In accordance with ANSI B109.1 or ANSI B109.2.
 - .2 Measurement Canada accredited where required by AHJ.
 - .3 Ratings:
 - .1 Gas Pressures and Flow Rates:
 - .1 Up to 690 mbar and flow rates up to 7.1 m³/hr, at 0.5-inch w.c. differential.
 - .2 Up to 1724 mbar and flow rates up to 17.8 m³/hr, at 0.5-inch w.c. differential.
 - .3 Up to 1724 mbar and flow rates up to 22.7 m³/hr, at 0.5-inch w.c. differential.
 - .2 Temperature Compensation: Minus 34°C to 60°C.
 - .4 LCD/LED multi-digit display.
 - .5 Metric or imperial units as reviewed with Consultant.
 - .6 Tamper-resistant.
 - .7 Die-cast aluminum case.
 - .8 Oil-impregnated, self-lubricating bushings.
 - .9 Moulded, convoluted diaphragms and rigid, reinforced flag rods.
 - .10 Graphite-filled phenolic valves and long-life, low friction, grommet seals.
 - .11 Non-temperature compensated or temperature compensated suiting intended applications.
 - .12 Hub connection of sizes suiting intended applications.
 - .13 Polyester primer with polyurethane top coat, corrosion-resistant and weather-resistant.
 - .14 Security seals that indicate tampering.
 - .15 Meter bars suiting intended applications.
 - .16 Regulators suiting intended applications.
 - .17 Remote Volume Pulsars: Provide on meters to supply accurate pulse outputs directly from meter indexes for applications such as:

- .1 Transmitting data to advanced metering infrastructure, automatic meter reading devices.
 - .2 Integration to building automation systems of Division 25
 - .3 Sending data to remote counters.
 - .4 Logging flow data.
 - .5 Operating flow control loops.
- .2 Smart Gas Meters:
- .1 Smart diaphragm gas meter in accordance with ANSI B109.1 and ASME B16.33.
 - .2 Ratings:
 - .1 Gas pressures and flow rates: Up to 690 mbar and flow rates up to 7.1 m³/hr, at 0.5-inch w.c. differential.
 - .2 Temperature Compensation: Minus 34°C to 60°C.
 - .3 Versatile software allows easily evolving from basic meter data collection to advanced analytics and data management.
 - .4 Measurement Canada accredited where required by AHJ.
 - .5 With gas-tight, integrated shutoff valve linked to onboard pressure and temperature sensors, meter enables almost instant, autonomous shutoff response to system anomalies such as overpressure, high-flow, leakage or fire.
 - .6 On-command shutoff for storm hardening, non-payment, delinquency and move-in/move-out.
 - .7 Autonomous shutoff response and alarms linked to configurable triggers:
 - .1 High or low pressure.
 - .2 High or low flow.
 - .3 High temperature and fire.
 - .4 Peripheral sensors for methane, seismic activity, corrosion and flooding.
 - .8 Volume, pressure, temperature, and meter status reporting for head-end analytics.
 - .9 Metric or imperial units as reviewed with Consultant.
 - .10 Tamper-resistant.
 - .11 Die-cast aluminum case.
 - .12 Oil-impregnated, self-lubricating bushings.
 - .13 Moulded, convoluted diaphragms and rigid, reinforced flag rods.
 - .14 Graphite-filled phenolic valves and long-life, low friction grommet seals.
 - .15 Non-temperature compensated or temperature compensated suiting intended applications.
 - .16 Hub connection of sizes suiting intended applications.
 - .17 Polyester primer with polyurethane top coat, corrosion-resistant and weather-resistant.
 - .18 Security seals that indicate tampering.
 - .19 Meter bars suiting intended applications.
 - .20 Regulators suiting intended applications.
 - .21 Fully integrated communications module with software and offering simplified wireless communication solution that includes:
 - .1 Communication using Bluetooth and 900-MHz mesh networks.

- .2 Open and universal standards for interoperability between systems and assets.
- .3 Vendor-agnostic platform.
- .4 Utilizes existing infrastructure from industry standard partners.
- .5 Requires zero proprietary network infrastructure.
- .6 Simple integration with utility billing and other third-party applications.
- .7 Federally-licensed bands designated for machine-to-machine communications.
- .8 Interface compatible with building automation system of Division 25
- .22 Meter Functions:
 - .1 Monitoring of mechanical pressure regulator health.
 - .2 Automatic meter identification.
 - .3 Execute authorized meter functions.
 - .4 Read/store meter data.
 - .5 Read meter data and store meter reading.
 - .6 Capture and store meter location and photo.
 - .7 View Meter Data:
 - .1 Status (Identification, Diagnostic, Security, Battery, Time, Pressure, Temp).
 - .2 Consumption (Current, Previous).
 - .3 Logbooks (Events, Metrological, Parameters).
 - .4 Load Profile (Hourly, Daily).
 - .8 Valve Open (Connect).
 - .9 Valve Close (Disconnect).
 - .10 Change Time.
 - .11 Role-based security – receive from server (configure in Admin station):
 - .1 List of authorized meters.
 - .2 List of authorized meter functions.
 - .12 Send to Server:
 - .1 Meter Readings.
 - .2 Audit Logs.
- .23 Batteries: Field replaceable lithium thionyl chloride batteries with battery life of 20 years.

2.08 EMERGENCY GAS SHUT-OFF STATIONS

- .1 Manually operated remote shutdown station for immediately shutting down gas supply.
- .2 Features:
 - .1 Minimum 30 mm mushroom head operators with maintained pull to reset operations.
 - .2 Surface Mounting:
 - .1 Metallic faceplate with stainless steel screws.
 - .2 Industrial grade, NEMA 4 rated, die-cast zinc enclosures.
 - .3 Flush Mounting:
 - .1 Over-sized non-metallic faceplate with stainless steel screws.

- .2 NEMA 4 rated, non-metallic backbox enclosures.
- .4 Contact blocks of type suiting control of connected devices.
- .5 NPT conduit entrances.
- .6 Label with appropriate identification letterings typically:
 - .1 White lettering on red background indicating function.
 - .2 Red lettering on white background indicating operator type.
- .7 Hinged polycarbonate carbonate preventing accidental operation.

2.09 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Flexible Stainless Steel Piping, Fittings and Joints:
 - .1 Tru-Flex, Pro-Flex.
 - .2 Titeflex, Gastite.
 - .3 OmegaFlex, TracPipe.
- .2 Earthquake Activated Automatic Shut-Off Valves:
 - .1 Equal to Pacific Seismic Products, KOSO Model 315.
- .3 Ball Type Shutoff Valves:
 - .1 Neo.
 - .2 Kitz.
 - .3 Toyo.
- .4 Pressure Regulators:
 - .1 Maxitrol.
 - .2 Emerson-Fisher.
 - .3 Circor-Leslie Controls.
- .5 Natural Gas Convenience Outlets:
 - .1 MB Sturgis.
 - .2 Fairview.
- .6 Natural Gas Check Meters:
 - .1 Honeywell, Elster.
 - .2 Itron.
 - .3 Sensus.
- .7 Emergency Gas Shut-Off Stations:
 - .1 Burnaby.
 - .2 STI.
 - .3 BeaconMedaes.
 - .4 IDEC.

3. Execution

3.01 NATURAL GAS SERVICE

- .1 Make arrangements with natural gas supply utility for installation of natural gas service piping with gas pressure regulator and meter assembly.
- .2 Provide seismic activated automatic shut-off valve in gas service piping outside building in accordance with valve manufacturer installation instructions and AHJ.
- .3 Provide angle iron framed wire mesh enclosure around valve and bolt to wall. Refer to Division 05 for metal fabrication requirements.
- .4 Provide 2 m high minimum 200 mm diameter Schedule 80 galvanized steel concrete filled bollards at meter-regulator location in pattern to protect meter-regulator. Install pipe straight and plumb 1.2 m below grade in continuous 600 mm diameter reinforced concrete footing. Smoothly crown top of concrete above top of pipe. Refer to Division 05 for metal fabrication requirements and Division 03 for concrete.

3.02 INSTALLATION OF NATURAL GAS PIPING

- .1 Install in accordance with CSA B149.1, requirements of AHJ, and as noted.
- .2 Provide piping as follows:
 - .1 Aboveground Piping: Uncoated Schedule 40 black steel, hard temper or soft copper, or, where permitted by AHJ, flexible stainless steel.
 - .2 Schedule 40 Black Steel:
 - .1 Pipe up to and including 50 mm diameter: Screwed.
 - .2 Pipe larger than 50 mm diameter: Welded joints.
- .3 Where approved for use by AHJ, install flexible stainless steel pipe in accordance with pipe manufacturer instructions.
- .4 Size supports for roof mounted piping at height accommodating roof slope and required piping slope, and permitting installation of low point dirt pockets.
- .5 Provide full pipe diameter 150 mm long drip or dirt pockets at bottom of vertical risers, at piping low points, at connections to equipment, and where required to complete installations.
- .6 Rough-in natural gas piping for equipment. Prior to roughing-in, obtain accurately dimensioned rough-in drawings for equipment and review locations with Consultant. Provide piping and connect to installed equipment. Provide shut-off valves in piping connections to equipment.
- .7 Install and mount solenoid valve in gas piping to kitchen cooking equipment.
- .8 Maintain minimum depth of burial of underground natural gas piping of 600 mm, unless otherwise required by AHJ.
- .9 Refer to Section 23 05 15 - Common Installation Requirements for HVAC Pipework, for additional requirements.
- .10 Refer to Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping, for piping expansion fittings, alignment guides, anchors and flexible connections, for additional requirements.
- .11 Refer to Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment, for additional requirements.

3.03 INSTALLATION OF VALVES

- .1 Provide valves with stems upright or horizontal, unless otherwise noted. Prior to installation, review with Consultant.

- .2 Install valves at branch take-offs to isolate pieces of equipment, and suiting intended applications.
- .3 Where required, install seismic activated automatic shut-off valve in gas service piping outside building in accordance with valve manufacturer installation instructions. Provide angle iron framed wire mesh enclosure around valve and bolt to wall.
- .4 Locate valves for easy accessibility and maintenance.
- .5 Provide additional installation requirements in accordance with Section 23 05 24 - Valves.

3.04 INSTALLATION OF PRESSURE REGULATORS

- .1 Provide vented pressure regulators in gas distribution piping and suiting intended applications.
- .2 Install regulating stations in accordance with CSA B149.1.
- .3 Provide 6 mm diameter test ports upstream and downstream of each regulator assembly.
- .4 Locate outdoor regulating stations minimum of 300 mm away from walkways, and 3.1 m away from equipment air intakes and building openings. Provide vent piping and terminate vents in turn-down elbow fitting with bronze bug screen secured in place.
- .5 Locate indoor regulating stations in locations accessible without use of ladders or lifts. Do not combine vents. Extend vent piping up through roof 3.1 m away from equipment air intakes and building openings and terminated in turn-down elbow fitting with bronze bug screen secured in place.
- .6 Install insulated sleeve for each natural gas pressure regulator vent pipe penetrating roof.
- .7 Identify operating set-points, relief settings and vent arrangements for each regulating station on as-built record drawings.

3.05 INSTALLATION OF NATURAL GAS CONVENIENCE OUTLETS

- .1 Provide natural gas convenience outlets and wall-mount.
- .2 Provide shut-off valve in connecting piping. Prior to roughing-in, review exact location with Consultant. Secure outlet rigidly in place.

3.06 INSTALLATION OF NATURAL GAS CHECK METERS

- .1 Provide natural gas check meter and accessories.
- .2 Install in accordance with manufacturer instructions.
- .3 Provide control wiring for gas meters and connect to BMA/BAS for meter data integration. Coordinate work with requirements of Division 25.

3.07 INSTALLATION OF EMERGENCY GAS SHUT-OFF STATIONS

- .1 Provide stations in locations.
- .2 Mount surface stations to wall constructions with fastenings suiting wall construction and manufacturer instructions.
- .3 Mount flush station backboxes recessed in walls. Secure faceplates to backboxes.
- .4 Connect to devices providing shut-off operations suiting intended applications.

3.08 CLEANING

- .1 Perform cleaning work in accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems and CSA B149.1.

3.09 ADJUSTING

- .1 Purging: Purge after pressure test in accordance with CSA B149.1.

3.10 IDENTIFICATION

- .1 Identify piping systems in accordance with CSA B149.1 and AHJ.
- .2 Paint natural gas piping aboveground (interior and exterior) with two coats of safety yellow enamel applied over primer, and label with coil type vinyl identification makers with direction flow arrows. Refer to Division 09 for additional painting requirements.
- .3 For underground gas piping, provide continuous 75 mm wide yellow PVC warning tape suitable for direct burial, with "CAUTION - GAS LINE BURIED BELOW" wording at 750 mm intervals located above pipe approximately 250 mm below grade.
- .4 Identify products and check lettering.
- .5 Provide additional identification in accordance with AHJ requirements.

3.11 FIELD QUALITY CONTROL

- .1 Pre-Start-Up Inspections:
 - .1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.
 - .2 Check gas trains.
 - .3 Check emergency shut-off stations.
 - .4 Arrange for inspection and approvals of installation by AHJ.
- .2 Site Tests, Inspection and Verification:
 - .1 Test system in accordance with CSA B149.1, and requirements of AHJ.
 - .2 Refer to Section 23 08 13 - Performance Verification HVAC Systems.
 - .3 Test performance of components.
- .3 Obtain compliance certificates and submit with reports.
- .4 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/Sheet Metal and Air Conditioning Contractors' National Association (ANSI/SMACNA):
 - .1 ANSI/SMACNA 006-[2020], HVAC Duct Construction Standards - Metal and Flexible.
 - .2 ANSI/SMACNA 008-[2008], IAQ Guideline for Occupied Buildings Under Construction.
 - .3 ANSI/SMACNA 011-[2017], Thermoset FRP Duct Construction Manual.
 - .4 ANSI/SMACNA 016-[2012], HVAC Air Duct Leakage Test Manual.
- .2 American National Standards Institute/Sheet Metal and Air Conditioning Contractors' National Association/ American Society of Heating, Refrigerating and Air-Conditioning Engineers (ANSI/ ASHRAE/SMACNA):
 - .1 ANSI/ASHRAE/SMACNA 126-[2020], Standard - Method of Testing HVAC Air Ducts (ANSI/SMACNA Approved).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - .1 ASHRAE Handbook - Fundamentals, [2021].
 - .2 ASHRAE Handbook - HVAC Systems and Equipment, [2020].
- .4 ASTM International (ASTM):
 - .1 ASTM A167-[99(2017)], Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - .2 ASTM A480/A480M-[20a], Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .3 ASTM A635/A635M-[15], Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements For.
 - .4 ASTM A653/A653M-[20], Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
 - .5 ASTM B209/B209M-[21a], Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .6 ASTM C582-[09(2016)], Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
 - .7 ASTM D3982-[21], Standard Specification for Contact Molded "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Ducts.
 - .8 ASTM D2996-[17], Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
 - .9 ASTM E119-[20], Standard Test Methods for Fire Tests of Building Construction and Materials.
 - .10 ASTM E814-[13a(2017)], Standard Test Method for Fire Tests of Penetration Firestop Systems.
 - .11 ASTM E2336-[20], Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.

- .12 ASTM F38-[18], Standard Test Methods for Creep Relaxation of a Gasket Material.
- .5 CSA Group (CSA):
 - .1 CSA A23.1-[19], Concrete Materials, and Methods of Concrete Construction.
 - .2 CSA A23.2-[19], Test Methods and Standard Practices for Concrete.
 - .3 CSA S269.1-[16(R2021)], Falsework and Formwork.
 - .4 CSA Z317.2-[19], Special Requirements for Heating, Ventilation, and Air-Conditioning (HVAC) Systems In Health Care Facilities.
- .6 National Fire Protection Association (NFPA):
 - .1 NFPA 90A-[2024], Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-[2024], Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 96-[2024], Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .7 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S115-[2023], Standard Method of Fire Tests of Firestop Systems.
 - .2 CAN/ULC-S144-[12-R2017], Standard Method of Fire Resistance Test - Grease Duct Assemblies.
 - .3 CAN/ULC-S662-[09 (R2021)], Standard for Factory-Built Grease Ducts.
 - .4 CAN/ULC-S102-[2018-REV1], Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .8 Underwriters Laboratories (UL):
 - .1 UL 1978-[Ed. 4, 2010], Standard For Grease Ducts.
 - .2 UL 2221-[Ed. 2, 2010], Standard For Tests of Fire Resistive Grease Duct Enclosure Assemblies.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include following:
 - .1 Fire-rated duct:
 - .1 Documentation identifying manufacturer is ULC listed to size requirements as noted.
 - .2 Manufacturer installation compliance certificate.
 - .2 Manufacturer colour chars for products noted with selection of finish colours.
- .3 Samples:

- .1 Prior to start of Work, submit for review, samples of duct fittings, including particulars such as gauge sizes, welds and configurations.
- .4 Construction Indoor Air Quality (IAQ) Management Plan:
 - .1 Submit IAQ Plan for pre-occupancy and construction phases of building.
 - .2 During construction meet or exceed requirements in accordance with ANSI/SMACNA 008.
- .5 Submit compliance certificates, and testing and verification reports.

1.03 DEFINITIONS

- .1 Low Pressure: Static pressure in duct less than 500 Pa and velocities less than 10 m/s.
- .2 Medium Pressure: Static pressure in duct less than 1500 Pa and velocities greater than 10 m/s.
- .3 High Pressure: Static pressure over 1500 Pa and less than 2500 Pa and velocities greater than 10 m/s.
- .4 Duct Sizes: Inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.

2. Products

2.01 SEAL CLASSIFICATION

- .1 Classifications Pressure Ratings:

Maximum Pressure Pa	SMACNA Seal Class
> 1000	[A]
750	[B]
500	[C]
250	[C]
125	[C]
125	[Unsealed]

- .2 Seal Classification:
 - .1 Class A: Longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
 - .2 Class B: Longitudinal seams, transverse joints and connections made airtight with gaskets, tape or combination.
 - .3 Class C: Transverse joints and connections made air-tight with gaskets, tape or combination. Longitudinal seams unsealed.
 - .4 Unsealed seams and joints.

2.02 DUCT SEALANT

- .1 Sustainability Characteristics:

- .1 Adhesives and Sealants:
 - .1 In accordance with respective product specified requirements.
 - .2 In accordance with Section 01 35 22 - Sustainability Product Requirements.
- .2 VOC limit:
 - .1 In accordance with respective product specified requirements.
 - .2 In accordance with Section 01 35 22 - Sustainability Product Requirements.
- .2 Sealant:
 - .1 Oil resistant, water-based, polymer type, non-flammable duct sealant.
 - .2 Indoor and outdoor permanently flexible.
 - .3 Resists mold and mildew.
 - .4 Maximum flame spread rating of 5 and smoke developed rating of 0 when tested in accordance with CAN/ULC-S102.
 - .5 Temperature range of minus 30°C to 93°C.

2.03 TAPE

- .1 Tape: Polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.04 DUCT LEAKAGE

- .1 Refer to Part 3 – Execution.

2.05 FITTINGS

- .1 Fabrication: In accordance with ANSI/SMACNA 006.
- .2 Fabricate continuously welded medium and high-pressure round and oval duct fittings of one gauge heavier than gauges noted for duct size.
- .3 Securely fasten and seal joints in accordance with SMACNA standards using appropriate methods and materials. Provide joints 100 mm cemented, brazed or electric welded. Prime coat weld joints.
- .4 Reinforce fittings as required by SMACNA based on the size and pressure class.
- .5 Fabricate elbows of five-piece construction.
- .6 Provide standard 45° take-offs unless otherwise noted where conical 90° tee take-off connections may be used. Brace with truss couplings or angle flanges with gaskets bolted at 150 mm centers.
- .7 Radiused Elbows:
 - .1 Rectangular:
 - .1 Construct tees, bends, and elbows with radius of not less than 1.5 times width of duct on centre line.
 - .2 Where not possible and where rectangular elbows used, provide air foil turning vanes of type in accordance with ANSI/SMACNA 006.
 - .3 Where acoustical lining is provided, provide turning vanes of perforated metal type with mineral fibre inside.
 - .2 Round:
 - .1 Smooth radius.

- .2 Centreline Radius: 1.5 times diameter.
- .8 Mitred Elbows Rectangular:
 - .1 To 407 mm: With double thickness turning vanes.
 - .2 Over 407 mm: With double thickness turning vanes.
- .9 Branches:
 - .1 Rectangular main and branch: With radius on branch 1.5 times width of duct.
 - .2 Round main and branch: Enter main duct at 45 degrees with conical connection.
- .10 Provide volume control damper in branch duct near connection to main duct. Provide main duct branches with volume control damper. Do not use splitter dampers in place of volume control dampers.
- .11 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
- .12 Offsets: As noted with short radiused elbows.
- .13 Obstruction Deflectors:
 - .1 Maintain full cross-sectional area.
 - .2 Maximum included angles: As for transitions.

2.06 GALVANIZED STEEL DUCTS

- .1 General:
 - .1 Hot dip galvanized steel sheets.
 - .2 In accordance with ASTM A653/A653M.
 - .3 Z180/G60 galvanizing for bare uncovered duct and with finish paint.
 - .4 Z275/G90 galvanizing for other galvanizing.
 - .5 Thickness, Fabrication and Reinforcement: In accordance with ANSI/SMACNA 006, unless otherwise noted.
 - .6 Joints: In accordance with ANSI/SMACNA 006.
- .2 Rectangular:
 - .1 Lock forming grade.
 - .2 Shop fabricated, minimum #26 gauge.
- .3 Round:
 - .1 Factory machine fabricated, spiral, mechanically locked flat seam.
 - .2 Single wall duct, fittings and couplings.
- .4 Flat Oval:
 - .1 Factory machine fabricated, single wall.
 - .2 4-ply spiral lock seam duct, fittings and couplings.

2.07 GALVANIZED STEEL ROUND PVC COATED DUCTS

- .1 Factory made, Z275/G90 galvanized steel, in accordance with ASTM A653/A653M.
- .2 Fittings with Metal Gauges: In accordance with ANSI/SMACNA 006.

- .3 Pressure Rating: 2.5 kPa, in accordance with ANSI/SMACNA 006.
- .4 Coating: 4 mm thick PVC permanently fused to both sides of duct, fittings and sleeve joint pieces.
- .5 Type 316 stainless steel sheet metal screws and support hardware.

2.08 STAINLESS STEEL DUCTS

- .1 Rectangular:
 - .1 300 Series stainless steel, type 304 or type 316 as specified in Part 3.
 - .2 In accordance with ASTM A167 and ASTM A480.
 - .3 Finishes:
 - .1 #4 finish where bare (uncovered) and exposed in finished areas.
 - .2 #2B finish elsewhere.
 - .4 Metal gauges: In accordance with ANSI/SMACNA 006, suiting duct location and working pressure classification.
 - .5 Stainless steel support hardware matching duct material.
- .2 Round:
 - .1 Factory made, spiral, mechanically locked flat seam.
 - .2 Single wall duct fabricated from type 316 stainless steel.
 - .3 In accordance with ASTM A240.
 - .4 Metal gauges: In accordance with ANSI/SMACNA 006 for 2.5 kPa pressure.
 - .5 Fittings: Type 316 stainless steel equipped with leak-proof stainless steel couplings secured to connecting duct by means of stainless steel sheet metal screws and duct sealer.
 - .6 Duct system performance: In accordance with SMACNA Leakage Class 3 requirements at system design static pressure.
 - .7 Finishes:
 - .1 #4 finish where bare (uncovered) and exposed in finished areas.
 - .2 #2B finish elsewhere.
- .3 Round and Lined:
 - .1 Double wall self-sealing duct system.
 - .2 Constructed from type 316 stainless steel.
 - .3 In accordance with ASTM A240.
 - .4 Consisting of 24 kg/m³ density, 25 mm thick glass fibre insulation in accordance with NFPA 90A and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102.2 and wrapped in thick non-woven polyester fabric, sandwiched between double wall duct and fittings.
 - .5 Spiral, mechanically locked, flat seam outer casing, and perforated inner liner with 3.2 mm perforations on 6.4 mm staggered centres.
 - .6 Fittings and coupling: Constructed as for ducts and air-tight in accordance with SMACNA Leakage Class 3 requirements.
 - .7 Finishes:
 - .1 #4 finish where bare (uncovered) and exposed in finished areas.
 - .2 #2B finish elsewhere.

- .4 Thickness, Fabrication and Reinforcement: In accordance with ANSI/SMACNA 006, unless otherwise noted.
- .5 Joints: In accordance with ANSI/SMACNA 006.

2.09 ALUMINUM DUCTS

- .1 Aluminum Type: 3003-H-14. In accordance to ASTM B209.
- .2 In accordance with ANSI/SMACNA 006 suiting duct working pressure classification.
- .3 Factory fabricated, water-tight and smooth interior.
- .4 Thickness, Fabrication and Reinforcement: In accordance with ANSI/SMACNA 006, unless otherwise noted.
- .5 Joints: In accordance with ANSI/SMACNA 006.
- .6 Type 316 stainless steel sheet metal screws and support hardware.
- .7 Round: Single wall duct, and fittings of spiral lockseam construction with site sealed beaded sleeve (slip type) joints.

2.10 BLACK STEEL DUCTS

- .1 Black steel sheet construction in accordance with ASTM A635/A635M.
- .2 Fire-resistant.
- .3 Thickness: 1.2 mm, unless otherwise noted.
- .4 Fabrication:
 - .1 Ducts and fittings in accordance with ANSI/SMACNA 006.
 - .2 Fully welded construction achieving leak proofing.
- .5 Reinforcement: As noted and suiting intended applications.
- .6 Joints: Continuous weld.
- .7 Angle bar frame flanges, unless otherwise noted.

2.11 FIBERGLASS REINFORCED PLASTIC (FRP) DUCTS

- .1 Factory fabricated rectangular or round FRP duct and fittings in accordance with:
 - .1 ASTM C582.
 - .2 ASTM D2996.
 - .3 ASTM D3982.
 - .4 ANSI/SMACNA 011.
- .2 Resin:
 - .1 25/50 flame spread/smoke rating tested in accordance with CAN/ULC-S102.
 - .2 Pigment coloured as selected from manufacturer standard colours.
 - .3 Thixotropic resin paste sealed and fibreglass cloth and resin.
 - .4 Overwrapped bell and spigot joints for round ducts.
 - .5 Air-tight gasketed flanged joints.
 - .6 Type 316 stainless steel bolts, lock washers and nuts for rectangular ducts.
 - .7 Type 316 stainless steel support hardware.

2.12 LABORATORY EXHAUST DUCTWORK (LXD)

- .1 Components and Requirements:
 - .1 Prefabricated flanged duct sections including joints constructed of minimum 1 mm thick (18 gauge) type 316 stainless steel.
 - .2 Duct constructed as noted in round or rectangular configuration.
 - .3 Gasket Materials:
 - .1 Supplied with LXD system.
 - .2 Consisting of material chemically inert and resists creep relaxation to 25% when tested in accordance with ASTM F38.
 - .4 Two-hour Fire Resistance:
 - .1 Provide where noted and as required by codes and AHJ.
 - .2 To gain specified fire resistance rating, external insulation ductwork materials are acceptable for use.
 - .3 Two-hour rated, "0" clearance, fire resistive assemblies: Tested in accordance with ASTM E119 requirements.
 - .4 Fire-resistant Duct Assemblies:
 - .1 Not exceed flame spread rating of 0 when tested in accordance with CAN/ULC-S102.
 - .2 Not exceed smoke development rating of 0 when tested in accordance with CAN/ULC-S102.
 - .5 Through-penetration Firestopping Materials: Where ventilation duct passes through fire-rated floor or wall assembly, fire-stop through openings in accordance with ULC listings.

2.13 FACTORY INSULATED FIRE-RATED DUCTS

- .1 Pre-fabricated, 2-hour fire-rated, duct system.
- .2 ULC listed and labeled for fire-rated ventilation applications.
- .3 Double wall construction of non-combustible material that is impact and moisture resistant.
- .4 Galvanized steel inner liner and galvanized steel outer jacket.
- .5 Fittings and accessories, including support hardware.
- .6 External wraps or enclosures not required.

2.14 FACTORY INSULATED KITCHEN GREASE EXHAUST DUCTS

- .1 General:
 - .1 ULC listed and labeled, 2-hour fire rated.
 - .2 In accordance with NFPA 96, UL 1978 and CAN/ULC-S662.
 - .3 Zero clearance duct for use as grease exhaust duct for commercial kitchens.
- .2 Rectangular/Square:
 - .1 In accordance with CAN/ULC-S144.
 - .2 Pre-manufactured and non-combustible double wall construction.
 - .3 Materials:
 - .1 Inner Liner: Minimum #16 gauge black sheet steel.

- .2 Insulation: Minimum 75 mm high temperature dense fibre.
 - .3 Outer Jacket Insulation: Minimum #24 gauge galvanized steel.
 - .4 Complete with fittings and accessories and access and cleanout fittings where required.
- .4 Factory-fabricated grease duct assembly is to not require additional wraps or enclosures to achieve required fire-resistance rating.
- .3 Round:
 - .1 In accordance with UL 2221.
 - .2 Modular prefabricated rigid piping systems with flanged joints designed both quick assembly and pressure-sealing capabilities.
 - .3 Materials:
 - .1 Stainless steel double wall cylindrical construction.
 - .2 Inner Liner: Type 304 stainless steel.
 - .3 Insulation: 75 mm of high temperature fibre.
 - .4 Outer Jacket: Stainless steel.
 - .5 Complete with fittings and accessories, including access and cleanout fittings, flanges, expansion joints, structural supports and ancillary components for complete installations.

2.15 UNINSULATED KITCHEN GREASE EXHAUST DUCTS

- .1 Minimum #16 gauge black sheet steel liquid-tight ductwork with welded joints or listed in accordance with CAN/ULC-S662.
- .2 Access Doors:
 - .1 Grease-tight access doors.
 - .2 In accordance with NFPA 96.
 - .3 Fabricated of same material as duct and as large as possible, up to 600 mm in any dimension.
 - .4 Located:
 - .1 In sides of duct for ease of inspection and cleaning at each change in duct direction.
 - .2 At not less than 3 m in straight duct including risers.
 - .3 Not less than 40 mm from bottom of duct.

2.16 KITCHEN EXHAUST DUCT EXPANSION JOINTS

- .1 General:
 - .2 For round and rectangular low pressure duct for pressures ranging from full vacuum to 103 kPa.
 - .1 Construction: Carbon steel or stainless steel matching mating ducts.
 - .2 Sized: Suited specific duct and equipment.
- .3 Rectangular:
 - .1 All metal all welded construction provides leak tight design.
 - .2 End attachments: Flanges unless otherwise noted.
- .4 Round:

- .1 Designed for light weight circular ducting.
- .2 Bellows designed to absorb axial, lateral and angular movements without exerting high spring forces on system.
- .3 End connections: Fixed flange, floating flange, angle flange and weld end, suiting intended applications.

2.17 IN-SLAB EXHAUST DUCTS

- .1 Material: 300 mm x 45 mm spiral wound lockseam rectangular galvanized steel with a 3 m duct channel.
- .2 Encased Fittings in Concrete: Inlet boots, elbows, support brackets, soffit, and wall discharge and spiral wound duct.
- .3 Testing Rating: 3-hour fire rated in accordance in accordance with CAN/ULC-S115 and ASTM E814.
- .4 Impact Loading Rating: In accordance with CSA A23.1 and CSA A23.2.
- .5 Point Loading Rating: In accordance with CSA S269.1.

2.18 ROUND TO RECTANGULAR DUCT CONNECTIONS

- .1 Galvanized steel, flared, flanged or notched spin-on round duct take-off collars with locking dampers.
- .2 In accordance with ANSI/SMACNA 006.

2.19 HANGERS AND SUPPORTS

- .1 Hangers and Supports: In accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .2 Strap Hangers: In general, not used without review with and recommendation of acceptance from Consultant. Where Consultant recommends use for acceptance, provide of same material as duct, but next sheet metal thickness heavier than duct.
- .3 Complete with locking nuts and washers.
- .4 Hanger Configuration: In accordance with ANSI/SMACNA 006.
- .5 Hangers and Rods:
 - .1 Black steel duct: Black steel angles and rods.
 - .2 Galvanized steel duct: Galvanized steel angles and rods.
 - .3 Stainless steel duct: Stainless steel angles and rods.
 - .4 In accordance with:
 - .1 [ASHRAE Handbook - Fundamentals].
 - .2 [ASHRAE Handbook - HVAC Systems and Equipment].
 - .3 [ANSI/SMACNA 006]
 - .4 [Following table:]

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

- .6 Upper Hanger Attachments:
 - .1 Concrete: Manufactured concrete inserts.
 - .2 Steel Joist: Manufactured joist clamp and steel plate washers.
 - .3 Steel Beams: Manufactured beam clamps.

2.20 ROOF MOUNTED DUCT SUPPORTS

- .1 Adjustable duct support assemblies for installation without roof penetrations, flashings, or damage to roofing material.
- .2 Used for virtually any roofing system from flat roofs to roofs sloped up to 2 in 12.
- .3 Sized suiting duct size.
- .4 Bases: Injection moulded high density/high impact polypropylene with UV-inhibitors and antioxidants bases.
- .5 Framing:
 - .1 12 gauge tubular.
 - .2 [Hot dip galvanized steel with hot dip galvanized steel hardware.]
 - .3 [Stainless steel mill finish with 304 stainless steel hardware.]

2.21 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Sealant:
 - .1 Duro Dyne.
 - .2 Ductmate.
 - .3 H.B. Fuller (Foster).
- .2 Joint:
 - .1 Equal to Hyspan, Series 2500.
- .3 Factory Insulated Fire Rated Ductwork:
 - .1 Equal to DuraSystems, DuraDuct HP or DuraDuct GNX.
- .4 In-Slab Exhaust Ductwork:
 - .1 Equal to ECCO Manufacturing ,ECCODUCT.
- .5 Factory Insulated Kitchen Grease Exhaust Duct:
 - .1 Rectangular/Square:
 - .1 Equal to DuraSystems, DuraDuct KEX.
 - .2 Round:
 - .1 Equal to Selkirk, ZeroClear.

- .6 Roof Duct Supports:
 - .1 Equal to PHP Systems Design, Model PHP-D.

3. Execution

3.01 INSTALLATION - GENERAL

- .1 Perform work in accordance with:
 - .1 [ASHRAE Handbook - Fundamentals.]
 - .2 [ASHRAE Handbook - HVAC Systems and Equipment.]
 - .3 [ANSI/SMACNA 006.]
 - .4 [ANSI/SMACNA 008.]
 - .5 [NFPA 90A].
 - .6 [NFPA 90B].
 - .7 SMACNA Duct Cleanliness for New Construction Guidelines at the Advanced Level.
 - .8 CSA Z317.2.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
- .3 Insulate strap hangers within 100 mm of insulated duct and fully seat diffusers.
- .4 Support risers.
- .5 Install breakaway joints in ductwork on sides of fire separation.
- .6 Install flanged duct joints in accordance with manufacturer instructions.
- .7 Manufacture duct in lengths and diameter accommodating installation of acoustic duct lining.
- .8 Connect terminal units to medium or high-pressure ducts with 300 mm maximum length of flexible duct.
- .9 Install wire mesh screens for open-end return air ducts in ceiling spaces. Refer to Section 23 37 20 - Louvres, Intakes and Vents for wire mesh screen requirements.
- .10 Firestopping:
 - .1 Provide firestopping and smoke seal materials installations not distorting duct.
 - .2 Provide firestopping at retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 10 - Comprehensive Firestopping.
- .11 Grease Filters: Refer to Section 23 38 13 - Commercial Kitchen Hoods.

3.02 FABRICATION AND INSTALLATION OF GALVANIZED STEEL DUCTWORK

- .1 Provide ductwork of rectangular, round or flat oval. Where rectangular ductwork is noted, round or flat oval ductwork of equivalent cross-sectional area is acceptable subject to review with and recommended for acceptance by Consultant.
- .2 Duct dimensions noted are clear internal dimensions.

- .3 Unless otherwise noted, construct and install ductwork in accordance with ANSI/SMACNA 006 suiting duct pressure class designation of minimum 500 Pa positive or negative as applicable, minimum velocity of 10 m/s, and such that ductwork does not "drum". Cross-brake flat surfaces of rectangular ductwork. Provide duct system sealing in accordance with ANSI/SMACNA Seal Class A requirements.
- .4 Variable air volume ductwork from supply fans to boxes:
 - .1 As above but rectangular duct take-offs of double side straight taper type with take-off length equal to 0.5 times branch duct width but minimum 150 mm length.
 - .2 Double taper side included angle of minimum 60°.
- .5 Confirm routing of ductwork at site and site measure ductwork prior to fabrication. Duct dimensions may be revised suiting site routing and building element requirements if dimension revisions are reviewed with and recommended for acceptance by Consultant. Duct routing or dimension revisions suiting conditions at site are not grounds for claim for extra cost.
- .6 Where ductwork is run within or through open web steel joists, ductwork noted on mechanical drawings is schematic only. Modify ductwork to suit steel joist configuration, spacing, panel points, and cross-bridging at no additional cost. Refer to structural drawings.
- .7 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.
- .8 Install (but do not connect) duct system mounted automatic control components supplied as part of automatic control work.
- .9 Where noted, provide duct connections to fan powered heat transfer equipment with integral coils.
- .10 Flange connect ductwork to hot water reheat coils. Suspend coils independent of connecting ductwork as part of heat transfer work.
- .11 Support horizontal rectangular ducts inside building using trapeze hangers with, unless otherwise noted, galvanized steel channels, and galvanized steel hanger rods for exposed ducts and concealed ducts wider than 500 mm. Support hardware constructed of same material as duct for metal duct, and, unless otherwise noted, type 316 stainless steel for non-metal duct. Provide supports for "heavy" duct such as cementitious core duct suiting application and recommended for acceptance by Consultant.
- .12 Support round and flat oval ducts inside building for both uninsulated and insulated ducts exposed in finished areas:
 - .1 Using galvanized steel strap bands encircling duct with galvanized steel self-loading bracket joining ends of bands, secured at top of duct. (equal to Ductmate type BA).
 - .2 Bracket provides suspension point for threaded hanger rod.
 - .3 If duct is insulated, size strap suiting diameter of insulated duct.
 - .4 Unless otherwise noted, duct support hardware for metal duct is constructed of same material as duct.
 - .5 For non-metal duct, provide type 316 stainless steel duct support hardware.
- .13 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.

3.03 HANGERS

- .1 Strap Hangers: Install in accordance with ANSI/SMACNA 006.
- .2 Install angle hangers with locking nuts and washers.
- .3 Hanger Spacing:
 - .1 [ASHRAE Handbook - Fundamentals].
 - .2 [ASHRAE Handbook - HVAC Systems and Equipment].
 - .3 [ANSI/SMACNA 006].
 - .4 [Following Table:]

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

3.04 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Ductwork outside building or otherwise exposed to elements.
 - .2 Dishwasher exhaust.
 - .3 Shower exhaust ducts from grilles to duct main or riser.
 - .4 Outside air intakes.
 - .5 Minimum 3000 mm of duct mounted humidifiers or humidifier manifolds, in each direction.
 - .6 As noted.
- .2 Form bottom of horizontal duct without longitudinal seams.
- .3 Weld or solder joints.
- .4 Slope horizontal branch ductwork down towards fume hoods served.
- .5 Slope header ducts down toward risers.
- .6 Unless otherwise noted, fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve or trap primer suiting intended applications. Unless otherwise noted, discharge to open funnel drain.

3.05 INSTALLATION OF ROUND PVC COATED GALVANIZED STEEL DUCTWORK

- .1 Provide round PVC coated galvanized steel ductwork.
- .2 Provide round PVC coated galvanized steel ductwork for:
 - .1 .
 - .2 .
- .3 Construct underground in accordance with ANSI/SMACNA 006, section regards to Positive Pressure Class 10" W.C. with minimum metal gauges as follows:
 - .1 150 mm through 350 mm diameter: 28 gauge.
 - .2 400 mm through 660 mm diameter: 26 gauge.
 - .3 685 mm through 915 mm diameter: 24 gauge.
 - .4 940 mm through 1270 mm diameter: 20 gauge.

- .4 Install underground ductwork in accordance with under slab duct requirements of ANSI/SMACNA 006.

3.06 INSTALLATION OF LABORATORY EXHAUST DUCTWORK (LXD)

- .1 Install stainless steel ductwork in accordance with duct manufacturer instructions using support hardware supplied with duct.
- .2 Duct assembly and joints: Third party tested in accordance with ANSI/ASHRAE/SMACNA 126 meeting minimum 2.5 kPa positive pressure or 2.5 kPa negative pressure achieving Seal Class A.
- .3 Access doors provided where noted and to maintain pressure.
- .4 Provide fire-resistance rating and firestopping materials as required.
- .5 Test ductwork verifying flanged connections are structurally sound by way of third party testing to support 4 times load of duct weight.
- .6 When installation is complete, arrange, and include for duct manufacturer to visit site and examine duct installation. Make any revisions requested by manufacturer, and when manufacturer is satisfied with installation, obtain and submit compliance certificate certifying installation in accordance with ULC requirements.

3.07 INSTALLATION OF FACTORY INSULATED FIRE RATED DUCTWORK

- .1 Install ductwork in accordance with duct manufacturer instructions using support hardware supplied with duct.
- .2 When installation is complete, arrange, and include for duct manufacturer to visit site and examine duct installation. Make any revisions requested by manufacturer, and when manufacturer is satisfied with installation, obtain and submit compliance certificate certifying installation in accordance with ULC requirements.

3.08 INSTALLATION OF KITCHEN GREASE EXHAUST DUCT

- .1 Provide welded sheet steel kitchen grease exhaust ductwork from exhaust hoods to roof mounted exhaust fans, in accordance with NFPA 96.
- .2 Construct ductwork watertight with continuous externally welded seams and joints, cleanouts, duct expansion provisions, riser residue traps and other ancillary devices.
- .3 Clean and prime coat ground welds in black steel ducts.
- .4 Support ductwork at not greater than 1.5 m intervals. Install fasteners at hangers not to penetrate duct. Install without forming dips, sags or traps where grease residue might collect, and locate access door/cleanouts for ease of maintenance.
- .5 Slope horizontal ductwork 25 mm per 300 mm back to exhaust hood.

3.09 INSTALLATION OF FIBREGLASS REINFORCED PLASTIC (FRP) DUCTWORK

- .1 Provide rectangular fibreglass reinforced plastic ductwork.
- .2 Provide FRP ductwork for:
 - .1 .
 - .2 .
- .3 Install duct in accordance with duct manufacturer instructions and ANSI/SMACNA 011.

- .4 Secure duct in place with type 316 stainless steel angles, straps, hanger rods, and accessories. Provide strips of felt or neoprene material between duct and hanging and support hardware.

3.10 INSTALLATION IN-SLAB EXHAUST DUCTWORK

- .1 Provide in-slab concrete encased ductwork, with fittings and accessories.
- .2 Install duct with support brackets supplied with duct and coordinated with location of reinforcing steel, post tensioning cables and other structural slab component. Install duct in accordance with manufacturer installation instructions and requirements of Consultant
- .3 Make joints water-tight.

3.11 INSTALLATION OF ROOF MOUNTED DUCT SUPPORTS

- .1 Supply supports for roof mounted ductwork.
- .2 Hand adjustable structural supports to roofing trade on roof for installation and flashing into roof construction as part of roofing work. Accurately mark exact locations and spacing of structural supports and supervise installation. Provide properly sized hot dip galvanized structural steel angles between structural supports and secure in place on support studs. Support ductwork on angles and provide galvanized steel banding to secure ducts to angles.
- .3 Accurately mark location and spacing of roof support assemblies. At each plastic base location, carefully scrape away loose roof ballast (gravel) and other debris and dirt. Prime existing membrane with primer which is compatible with existing roofing components. Set bases in adhesive in accordance with manufacturer installation instructions. Scrape loose ballast back around and on bases. Install framing, and install ductwork on cross-members. Secure ductwork to cross-members with galvanized steel banding.

3.12 KITCHEN EXHAUST SYSTEMS

- .1 Install in accordance with NFPA 96.
- .2 Coordinate exhaust piping connections with hood/fan requirements.
- .3 Provide rigid ducting. Do not use flexible duct to change direction.

3.13 SEALING AND TAPING

- .1 Sealing:
 - .1 Apply sealant in accordance with manufacturer recommendations and ANSI/SMACNA 006.
 - .2 Before application, clean surfaces, dry, and free of grease, oil, and dirt, and dry.
 - .3 Before testing or operation, allow adequate cure time in accordance with manufacturer instruction..
 - .4 Inspect sealed joints for uniform application and integrity.
 - .5 Address deficiencies immediately to ensure air-tight seals.
- .2 Bed tape in sealant and recoat with minimum of one-coat of sealant to manufacturer recommendations.

3.14 FIELD QUALITY CONTROL

- .1 When installation is complete, review and inspect installation, test and verify operations.

- .2 Conduct visual inspection of ductwork components during and after installation to ensure compliance with design drawings, specifications, and industry standard.
- .3 Verify that duct sections are properly aligned, supported, and securely fastened to prevent sagging, distortion, or air leakage.
- .4 Temporarily cover open ends of ducts during construction.
- .5 Remove dirt and foreign matter from entire duct systems and clean duct system terminals and interior of air handling units prior to operating fans. Failure to protect finished materials or systems will not result in any back charges being accepted by Project.
- .6 Prior to starting supply air handling system, provide 50 mm thick glass fibre construction filters at fan equipment in place of permanent filters.
- .7 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.
- .8 Include labour for complete site walk-through with testing and balancing personnel following route of duct systems to be tested, adjusted and balanced for 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 result of this walk-through.
- .9 Duct Leakage Tests and Pressure Tests:
 - .1 In accordance with ANSI/SMACNA 016.
 - .2 Perform testing at duct pressure levels recommended by SMACNA for specific duct class being tested.
 - .3 Use either positive or negative pressure testing methods as appropriate for system design and as specified in ANSI/SMACNA 016 for specified duct class.
 - .4 Include maximum pressure data.
 - .5 Perform leakage tests in sections.
 - .6 Make trial leakage tests to demonstrate workmanship.
 - .7 Do not install additional ductwork until trial test results meet specified requirements.
 - .8 Test section minimum of 30 m long with not less than three branch takeoffs and two 90-degree elbows.
 - .9 Complete test before performance insulation or concealment Work.
 - .10 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .10 Prepare and submit IAQ Plan for pre-occupancy and construction phases of building.
- .11 Document test procedures, including preparation, execution, and results.
- .12 Submit detailed reports indicating tested sections, test pressures, measured leakage, and any deviations from specified leakage standards.
- .13 Perform corrective actions if test results exceed permissible leakage limits, necessary modifications and retesting procedures.
- .14 Final acceptance is contingent upon meeting or exceeding leakage performance as specified.
- .15 Obtain compliance certificates for fire rated installations. Submit with reports.
- .16 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/Sheet Metal and Air Conditioning Contractors' National Association (ANSI/SMACNA):
 - .1 ANSI/SMACNA 006-[2020], HVAC Duct Construction Standards - Metal and Flexible.
- .2 ASTM International (ASTM):
 - .1 ASTM A653/A653M-[2023], Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM E84-23d, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .3 National Fire Protection Agency (NFPA):
 - .1 NFPA 90A-[2024]- Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-[2024], Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
 - .3 NFPA 701-[2023], Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Pressure Relief Door:
 - .1 Include maximum pressure data.
- .3 Submit testing and verification reports.

2. Products

2.01 FLEXIBLE DUCT CONNECTORS

- .1 General:
 - .1 Manufacture: In accordance with ANSI/SMACNA 006.
 - .2 Frame: Galvanized sheet metal frame.
 - .3 Flame/Smoke Test: In accordance with NFPA 701.
 - .4 Flame/Smoke Rating: In accordance with ASTM E84.
- .2 Indoor/Outdoor Types:

- .1 Oil resistant, airtight and waterproof, woven fiber glass type material.
- .2 Hypalon Coating.
- .3 Temperature Rating: Minus 40°C to 121°C.
- .4 Flexible Connection Material (Standard Temperature Applications):
 - .1 Waterproof, fire-resistant, self-extinguishing, synthetic rubber coated on both sides, woven glass fabric.
 - .2 In accordance with NFPA 90A.
 - .3 Temperature rated at minus 45°C to 100°C.
 - .4 Minimum density of 0.8 kg/m².
- .3 High Heat Ductwork Types:
 - .1 Airtight and waterproof, woven fiberglass type material.
 - .2 Silicone rubber coating.
 - .3 Connectors Requirements: In accordance with NFPA 90A and NFPA 90B.
 - .4 Flexible Connection Material (High Temperature Applications):
 - .1 Waterproof, fire-resistant, self-extinguishing, silicone rubber coated on both sides, woven glass fabric.
 - .2 In accordance with NFPA 90A.
 - .3 Temperature rated at minus 55°C to 260°C.
 - .4 Minimum density of 0.6 kg/m².
- .4 Insulated Flexible Duct Types:
 - .1 Airtight, waterproof and non-porous.
 - .2 Resistant to grease, oil, gasoline and acid.
 - .3 Sheet metal permanently secured to fabric on both sides at seams, with seam locks.
 - .4 Fabrics:
 - .1 Flame-resistant reinforced vinyl.
 - .2 Thread Count: 28 x 14.
 - .3 Tensile Strength: 0.5 N/m² x 0.5 N/m².
 - .4 Tear Strength: 0.1 N/m² x 0.1 N/m².
 - .5 Low Temp: Minus 40°C.
 - .6 High Temp (Continuous): 82.2°C.
 - .5 Fibreglass Insulation:
 - .1 Thickness: Nominal 25 mm.
 - .2 2 layers of fabric insulation.
 - .3 RSI-Value of 0.73.
 - .4 Density: 28 kg/m³.
 - .5 Designed in accordance with NFPA-90A.
 - .6 Sheet Metal:
 - .1 Galvanized Steel.
 - .2 Thickness: 28 Gauge.
 - .3 In accordance with ASTM A653/A653M - G60.

2.02 ROUND TO RECTANGULAR DUCT CONNECTIONS

- .1 Galvanized steel, flared, flanged or notched "Spin-On" round duct take-off collars with locking dampers.
- .2 In accordance with ANSI/SMACNA 006.
- .3 Fit connections to avoid visible openings. Provide screws at uniform intervals of at most 381mm.

2.03 BREAKAWAY CONNECTIONS

- .1 Types:
 - .1 Suiting connecting duct in accordance with ANSI/SMACNA 006.
 - .2 Transverse joints, flanged, rectangular, round or oval ducts.
- .2 Accessories: Sheetmetal screws, nuts and bolts, cleats, collars, neoprene gaskets and ancillary devices.
- .3 Breakaway connections for fire damper or combination fire smoke damper:
 - .1 ULC listed and labeled.
 - .2 In accordance with NFPA 90A.
 - .3 In accordance with manufacturer requirements.

2.04 ACCESS DOORS IN DUCTS

- .1 In accordance with ANSI/SMACNA 006.
- .2 Sizes suitable for intended applications.
- .3 Unless otherwise noted, constructed of same material as duct with which they are associated.
- .4 Construction and airtightness suitable for duct pressure class used.
- .5 Non-Insulated Ducts:
 - .1 Sandwich construction of same material as duct.
 - .2 One sheet metal thickness heavier, minimum 0.6 mm thick, with sheet metal angle frame.
- .6 Insulated Ducts:
 - .1 Sandwich construction of same material as duct.
 - .2 One sheet metal thickness heavier, minimum 0.6 mm thick.
 - .3 Sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .7 Gaskets: Foam rubber or neoprene.
- .8 Hardware:
 - .1 Up to 300 mm x 300 mm: Two sash locks, with safety chain.
 - .2 300 mm to 450 mm: Four sash locks, with safety chain.
 - .3 450 mm to 1000 mm: Piano hinge and minimum two sash locks.
 - .4 Doors over 1000 mm: Piano hinge and two handles operable from both sides.
 - .5 Hold open devices.
 - .6 Glass viewing panels:
 - .1 Size as noted.

- .2 2 layers of laminated safety glass mounted in hot dipped galvanized steel panel.
- .3 Gasketing and mounting hardware.

2.05 TURNING VANES

- .1 General:
 - .1 Constructed of same material as duct with which they are associated.
 - .2 In accordance with ANSI/SMACNA 006.
 - .3 Vanes secure and stable in installed operating position. Where necessary, at certain velocities or pressures, weld vanes to runners on appropriate intervals along runners.
 - .4 Provide special provisions in vanes shape or angle for ductwork containing acoustic liner.
- .2 Square Elbows:
 - .1 Multiple-radius turning vanes interconnected with bars, reinforced suiting pressure and velocity of system.
- .3 Short Branch Ducts at Grille and Diffuser Connections:
 - .1 Air extractor type vanes equipped with matching bottom operated 90° opposed blade volume control damper.
- .4 Double-Wall:
 - .1 For construction of consistent double wall turning vanes systems, for purpose of directing air around mitered elbows.
 - .2 Dimpled seam available for 50 mm and 100 mm turning vanes.
 - .3 Material Options:
 - .1 G-60 galvanized steel.
 - .2 Stainless steel.
 - .3 Aluminum.
 - .4 Black Iron.
 - .5 PVC Coated.

2.06 INSTRUMENT TEST PORTS

- .1 Cast zinc alloy construction with heavy gauge zinc plated cap.
- .2 Neoprene expansion plug: Withstand up to 82°C and pressure rated to 620 kPa.
- .3 Various models suiting thickness of insulation.
- .4 Model with cam lock handles with neoprene expansion plug and handle chain.
- .5 Neoprene mounting gasket.

2.07 SPIN-IN COLLARS

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness: Corresponding to round duct standards.

2.08 DUCTWORK DRAIN POINTS

- .1 20 mm diameter leakproof moisture drain.

- .2 Funnel made of 12 gauge galvanized sheet metal and cannot be deformed.
- .3 Corrosion resistant threaded drain, nut and cap.

2.09 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Flexible Duct Connectors:
 - .1 Duro Dyne, DUROLON.
 - .2 Dyn Air. HYPALON.
- .2 Round to Rectangular Duct Connections
 - .1 Equal to Flexmaster.
- .3 Instrument Test Ports:
 - .1 Equal to Duro-Dyne, IP1 or IP2.
- .4 Ductwork Drain Points:
 - .1 Equal to Ductmate, Moisture Drain.

3. Execution

3.01 INSTALLATION OF FLEXIBLE CONNECTIONS

- .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As noted.
- .2 Length of Connection: 100 mm minimum.
- .3 Minimum distance between metal parts when system in operation: 75 mm.
- .4 Minimum 75mm of duct material (minimum 24 gauge) secured to each edge of flexible fabric and to duct/equipment.
- .5 Install in accordance with ANSI/SMACNA 006.
- .6 When fan is running:
 - .1 Ducting on sides of flexible connection are in alignment.
 - .2 Provide slack material in flexible connection.
 - .3 Connections arranged to not impose external forces on fabric.
- .7 Do not install flexible connections for changes in direction.

3.02 INSTALLATION OF BREAKAWAY CONNECTIONS

- .1 Install breakaway connections in accordance with manufacturer instructions, ANSI/SMACNA 006 and requirements of AHJ.
- .2 Select appropriate type of joints and materials suiting connecting materials and applications.

3.03 INSTALLATION OF ACCESS DOORS AND VIEWING PANELS IN DUCTS

- .1 Install access doors in ductwork for access to reheat coils, fire dampers, humidifier dispersion tubes and other components, providing access for maintenance or repair.
- .2 Install viewing panels in ductwork and plenums as noted.
- .3 Install in accordance with ANSI/SMACNA 006.
- .4 Locate doors for proper damper maintenance.
- .5 Identify access doors provided for fusible link damper maintenance with "FLD" stencil painted or marker type red lettering.
- .6 Submit sample of proposed duct access doors for review.
- .7 Where sectionalized fusible link dampers, or balancing dampers are provided in large ducts, provide plenum type access door. Reinforce ductwork suiting access door installed.
- .8 Door and Viewing Panels Sizing: As noted, and as required for intended applications.
- .9 Install access doors for following devices or in following locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Reheat coils.
 - .5 Elsewhere as noted.

3.04 INSTALLATION OF PRESSURE RELIEF DOORS

- .1 Provide pressure release access doors preventing duct system explosion or implosion as result of duct obstruction, such as closed fire damper preventing normal air flow through system. Size doors in accordance with requirements of Part 2 of this Section or as noted.
- .2 Pressure release doors in suction ducts or plenums. Mount access door assembly so door swings in and latch mechanism is on inside of duct or plenum. If latch mechanism is not accessible, provide standard access door at latch side of pressure release access door for maintenance purposes.
- .3 Adjust each latch mechanism by means of adjusting pin suiting static pressure of particular system in accordance with latch mechanism manufacturer instructions.

3.05 INSTALLATION OF TURNING VANES

- .1 Provide turning vanes in ductwork elbows:
 - .1 Where noted.
 - .2 Wherever else required due to site installation routing and duct elbow radius. Make special considerations to ensure that ductwork free area is maintained.
 - .3 Where recommended in accordance with ANSI/SMACNA 006.
- .2 Install volume extractor type turning vanes in short branch supply duct connections off mains to grilles and diffusers where noted.
- .3 Install in accordance with ANSI/SMACNA 006.

3.06 INSTALLATION OF INSTRUMENT TEST PORTS

- .1 Install in accordance with ANSI/SMACNA 006 and instrument manufacturer instructions.

- .2 Locate permitting easy manipulation of instruments for reading, adjusting, maintenance and replacement.
- .3 Install insulation port extensions.
- .4 Locations:
 - .1 Traverse Readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .4 As noted.
 - .5 As recommended by results of air quantity testing and balancing work.
 - .2 Temperature Readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as reviewed with and recommended by Consultant.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junctions of two converging air streams of different temperatures.
 - .5 As noted.
 - .6 As recommended by results of air quantity testing and balancing work.

3.07 INSTALLATION OF SPIN-IN COLLARS

- .1 At rectangular galvanized steel duct, accurately cut holes and provide flanged or "spin-in" round flexible duct connection collars. Seal joints with duct sealer.

3.08 INSTALLATION OF DUCTWORK DRAIN POINTS

- .1 Drill hole in duct walls for insertion of drain.
- .2 Position funnel and screw on with nut until sheet metal wall is drawn down into funnel.
- .3 Seal with gaskets or apply sealant.
- .4 Attach drain piping as noted.
- .5 Provide cap if there is no drainage pipe.

3.09 FIELD QUALITY CONTROL

- .1 When installation is complete, review and inspect installation, test and verify operations.
- .2 Testing and Performance Verification:
 - .1 Air quantity testing and balancing work for test ports.
 - .2 Pressure testing In accordance with Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .3 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute (AMCA):
 - .1 AMCA Publication 511-[21], Certified Ratings Program - Product Rating Manual for Air Control Devices.
- .2 American National Standards Institute/Air Movement and Control Association International (ANSI/AMCA):
 - .1 ANSI/AMCA Standard 500-D-[18], Laboratory Methods of Testing Dampers for Rating.
- .3 American National Standards Institute/Sheet Metal and Air Conditioning National Association (ANSI/SMACNA):
 - .1 ANSI/SMACNA 006-[2020], HVAC Duct Construction Standards - Metal and Flexible.
- .4 ASTM International (ASTM):
 - .1 ASTM A653/A653M-[20], Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .5 National Fire Protection Association (NFPA):
 - .1 NFPA 80-[2022], Standard for Fire Doors and Other Opening Protectives.
 - .2 NFPA 90A-[2024], Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .3 NFPA 92-[2021], Standard for Smoke Control Systems.
 - .4 NFPA 101-[2024], Life Safety Code.
 - .5 NFPA 105-[2022], Standard for Smoke Door Assemblies and Other Opening Protectives.
- .6 Sheet Metal and Air Conditioning National Association (SMACNA):
 - .1 SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, [5th Edition, 2002].
- .7 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-[2018-REV1], Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S112-[2010-R2021], Standard Test Method of Fire Test of Fire Damper Assemblies.
 - .3 CAN/ULC-S112.1-[2010-R2021], Standard for Leakage Rated Dampers for Use in Smoke Control Systems.
 - .4 CAN/ULC-S112.2-[2007-R2021], Standard Method of Fire Test of Ceiling Fire Stop Flap Assemblies.
 - .5 ANSI/CAN/UL/ULC 33-[2021], Heat Responsive Links for Fire-Protection Service.
- .8 Underwriters Laboratories (UL):
 - .1 ANSI/UL 555-[2020], Fire Dampers.

- .2 ANSI/UL 555S-[2020], Smoke Dampers.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Fire and Smoke Dampers:
 - .1 Indicate following types:
 - .1 Fire dampers.
 - .2 Smoke dampers.
 - .3 Firestop flaps.
 - .4 Operators.
 - .5 Fusible links.
 - .2 Indicate design details of break-away joints.
 - .4 Submit manufacturer certification that materials comply with specified performance characteristics and physical properties.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit compliance certificates, and testing and verification reports.

2. Products

2.01 BALANCING DAMPERS

- .1 Standards: In accordance with ANSI/AMCA Standard 500-D and ANSI/SMACNA 006.
- .2 Single Blade Dampers:
 - .1 Fabricate from same material as duct, but one sheet metal thickness heavier and V-groove stiffened.
 - .2 Size and configuration in accordance with ANSI/SMACNA 006. Unless otherwise noted, maximum height 100 mm.
 - .3 Locking quadrant with shaft extension, accommodating insulation thickness, as required for intended application.
 - .4 Inside and outside nylon end bearings.
 - .5 Channel frame of same material as adjacent duct, with angle stop.
- .3 Multi-Bladed Dampers:
 - .1 Factory manufactured of material compatible with duct.
 - .2 Opposed Blade: Configuration, metal thickness and construction in accordance with ANSI/SMACNA 006.
 - .3 Maximum Blade Height: 100 mm, unless otherwise noted.
 - .4 Bearings: Self-lubricating nylon bushings.
 - .5 Linkage: Shaft extension with locking quadrant.
 - .6 Channel frame of same material as adjacent duct, with angle stop.

- .7 Maximum Leakage: As noted and suiting intended applications.
- .4 Splitter Dampers:
 - .1 Minimum #20 gauge damper blade constructed of same material as duct, reinforced suiting blade size, system velocity, and preventing chatter.
 - .2 Quadrant regulator:
 - .1 Consisting of heavy 12-gauge handle with U bend.
 - .2 Firmly clamps square bearing pin front and back, securing it against quadrant frame.
 - .3 Backup washers preventing leakage, long square bearing pin and slide pin.

2.02 OPERATING DAMPERS

- .1 Standards: In accordance with ANSI/AMCA Standard 500-D and ANSI/SMACNA 006.
- .2 Multi-Blade Dampers:
 - .1 Parallel blade type for open-shut service, opposed blade type for modulating and mixing applications, unless otherwise noted.
 - .2 Blades: Extruded aluminum, interlocking airfoil blades, with EPDM blade gasket seals mechanically fastened in integral slot.
 - .3 Frame: Extruded aluminum frame, damper frame not less than 2 mm thickness, extruded silicone or TPE frame seals mechanically fastened in integral slot.
 - .4 Linkage: Plated steel linkage of metal thickness to prevent warping or bending during damper operation, concealed in frame.
 - .5 Bearings: Polyoxymethylene (POM) thermoplastic inner bearing fixed around aluminum hexagon blade pivot pin, polycarbonate outer bearing in frame.
 - .6 Operator:
 - .1 Control operators compatible with damper, suiting specific applications and operations.
 - .2 Shaft mounted, spring return, fail safe in normally open or normally closed position.
 - .3 Sized to control damper against maximum pressure or dynamic closing pressure, whichever is greater, suiting sizes of dampers involved, and providing sufficient force to maintain damper rated leakage characteristics.
 - .4 Damper position indicator, and external adjustable stops limiting length of stroke in either direction, mounted on corrosion-resistant adjustable bracket.
 - .5 Operating arms with double yoke linkages and double set screws for fastening to damper shaft.
 - .6 Operators for dampers connected to building fire alarm system or to freeze protection devices: Equipped with additional relays permitting dampers to respond and go to required position in less than 15 seconds upon receipt of signal.
 - .7 Enclosures suitable in for environments in which they are located.
 - .7 Performance: Leakage and pressure drop as noted and suiting specific applications and operations.
 - .8 Maximum single section blade length of 1 m.

- .9 Provide jackshafts for dampers greater than two sections wide.
- .10 Insulated Aluminum Dampers:
 - .1 Frames: Insulated with extruded polystyrene foam with RSI 0.88.
 - .2 Blades: Constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.
- .3 Disc Type Dampers:
 - .1 Frame: Brake formed, welded, 1.6 mm thick, galvanized steel in accordance with ASTM A653/A653M.
 - .2 Disc: Spin formed, 1.6 mm thick, galvanized steel in accordance with ASTM A653/A653M.
 - .3 Gasket: Extruded neoprene, field replaceable, with ten-year warranty.
 - .4 Bearings: Roller self-lubricated and sealed.
 - .5 Operator: Control operators compatible with damper, linear stroke operator, spring loaded actuator, zinc-aluminum foundry alloy casting cam follower.
 - .6 Performance: Leakage and pressure drop suiting intended applications.
 - .7 Damper Insulated suiting intended application.
- .4 Back Draft Dampers:
 - .1 Counterbalanced backdraft dampers, vertical or horizontal mounting, 50 mm wide, sized as noted.
 - .2 Extruded aluminum frame, 2.3 mm nominal wall thickness, with mitred corners.
 - .3 Extruded aluminum blades, 1.3 mm nominal wall thickness on 92 mm centres, and with extruded PVC blade seals.
 - .4 Corrosion-resistant synthetic bearings.
 - .5 Adjustable plated steel counterweights mounted internally in airstream.
 - .6 Concealed blade linkage located out of airstream.
- .5 Relief Dampers:
 - .1 Automatic multi-leaf, dampers with ball bearing centre pivoted and counterweights set to open suiting intended application.
 - .2 Aluminum or galvanized steel construction, suiting intended applications.

2.03 FIRE AND SMOKE DAMPERS

- .1 Fire Dampers:
 - .1 ULC listed and labeled.
 - .2 In accordance with:
 - .1 ANSI/AMCA Standard 500-D.
 - .2 AMCA Publication 511.
 - .3 ANSI/UL 555.
 - .4 CAN/ULC-S112.
 - .5 NFPA 80, NFPA 90A and NFPA 101.
 - .6 SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.
 - .3 Type B or Type C (suiting intended applications) with folded curtain blade out of air stream, unless where damper size or location requires use of Type A dampers with curtain blade in air stream.

- .4 Factory fabricated for fire-rating requirement maintaining integrity of applicable fire wall or fire separation. Typically, ULC 1-1/2-hour or three-hour rated, as reviewed with Consultant, and in accordance with requirements of AHJ.
- .5 Construction:
 - .1 Frame: 22 gauge roll-formed G60 galvanized steel.
 - .2 Blades: Curtain type interlocking blades, 22 gauge roll-formed G60 galvanized steel.
 - .3 Fusible Link: 74°C, unless otherwise noted.
 - .4 Blade Closure: Stainless steel closure springs and galvanized steel locking ramps.
 - .5 Maximum Velocity Rating: 20 m/s @ 1 kPa, unless otherwise noted.
- .6 Automatic operating type having dynamic rating suitable for maximum air velocity and pressure differential to which it is subjected.
- .7 Top hinged with features suiting intended applications from following:
 - .1 Offset single damper.
 - .2 Round or square.
 - .3 Roll door type.
 - .4 Multi-blade hinged.
 - .5 Guillotine type.
 - .6 Interlocking type.
 - .7 Sized maintaining full duct cross-section.
 - .8 Vertical or horizontal installation.
- .8 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .9 Retaining angle iron frame: On full perimeter of fire damper, on both sides of fire separation being pierced, in accordance with damper manufacturer instructions.
- .10 Equip fire dampers with steel sleeve or frame, installed without disruption of ductwork or impairing damper operation.
- .11 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening, in accordance with damper manufacturer instructions. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling, in accordance with ULC Standards.
- .12 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .13 Install dampers so that centerline of damper depth or thickness is located in centerline of wall, partition or floor slab depth or thickness.
- .14 Dampers in ductwork other than galvanized steel have features as specified above, but are constructed of type 316 stainless steel.
- .15 Auxiliary components, suiting intended applications:
 - .1 Type 316 stainless steel frame and blades.
 - .2 Non-standard temperature fusible link.
 - .3 Pull tab release.
 - .4 Sealing.
 - .5 Factory fitted sleeves in custom lengths, gauges and transition styles.
- .2 Smoke Dampers:

- .1 ULC listed and labeled.
- .2 ULC Class I leakage rated for smoke.
- .3 In accordance with:
 - .1 ANSI/AMCA Standard 500-D.
 - .2 AMCA Publication 511.
 - .3 ANSI/UL 555S.
 - .4 CAN/ULC-S112.1.
 - .5 NFPA 90A, NFPA 92, NFPA 101 and NFPA 105.
 - .6 SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.
- .4 Construction:
 - .1 Frame: 16 gauge galvanized steel hat channel.
 - .2 Blades: 14 gauge galvanized steel formed airfoil, opposed action.
 - .3 Linkage: Concealed in frame. 12 gauge plated steel.
 - .4 Bearings: Self-lubricating and constructed of copper with approximately 10% tin and up to 1% iron.
 - .5 Axles: Plated steel double bolted to blades.
 - .6 Jackshaft: Cadmium plated steel.
 - .7 Jamb Seals: Cambered stainless steel.
- .5 Normally Closed Reverse Action Smoke Vent:
 - .1 Folding blade type, opening by gravity upon detection of smoke, or from remote alarm signalling device actuated by electro thermal link. Two flexible stainless-steel blade edge seals, providing constant sealing pressure.
- .6 Normally Open Smoke/Seal:
 - .1 Folding blade type, closing when actuated by means of electro thermal link or from remote alarm signalling device. Blade edge seals of flexible stainless steel, providing constant sealing pressure. Provide stainless steel negator springs with locking devices providing positive closure for units mounted horizontally in vertical ducts.
- .7 Motorized:
 - .1 Folding blade type, normally open with power on. When power is interrupted damper closes automatically.
- .8 Electro Thermal Link:
 - .1 Dual responsive fusible link which melts when subjected to local heat of typically 74°C, unless otherwise noted and from external electrical impulse of low power and short duration.
- .9 Dampers in ductwork other than galvanized steel have features as specified above but are constructed of type 316 stainless steel.
- .10 Auxiliary components, suiting intended applications:
 - .1 Side actuator mounting plate.
 - .2 Stainless steel bearings.
 - .3 Position indicator switch pack.
 - .4 Flanges.
 - .5 Factory fitted sleeves in custom lengths, gauges and transition styles.

- .3 Combination Fire and Smoke Dampers:
 - .1 Dampers:
 - .1 With features as specified for above separately specified fire dampers and smoke dampers.
 - .2 Combined Actuator:
 - .1 Electrical control system actuated from smoke sensor or smoke detection system and from fusible link.
 - .3 Factory Installed Sleeves:
 - .1 Minimum 400 mm length, dependent on wall thickness as verified onsite and in accordance with damper manufacturer instructions.
 - .2 Sleeves constructed of 20 gauge material matching damper, for sizes up to 2.1 m wide and 18 gauge for sizes greater than 2.1 m.
 - .3 Caulk sleeves in accordance with ULC requirements.
 - .4 Auxiliary components, suiting intended applications:
 - .1 Damper test switch for cycle testing.
 - .2 Duct smoke detectors.
 - .3 Dual temperature override sensors.
 - .4 Position indicator switch pack.
 - .5 Retaining angles.
 - .6 Factory fitted sleeves in custom lengths, gauges and transition styles.
- .4 Fire Stop Flaps and Thermal Blanket Material:
 - .1 Fire Smoke Flaps:
 - .1 ULC listed and labeled, and fire tested in accordance with CAN/ULC-S112.2.
 - .2 Constructed of minimum 1.5 mm thick sheet steel with 1.6 mm thick non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.
 - .3 Flaps held open with fusible link in accordance with ANSI/CAN/UL/ULC 33 and close at typically 74°C, unless otherwise noted.
 - .4 Dampers 300 mm and Larger: Ceramic fibre insulation on both sides of blades.
 - .5 Ceramic Fibre Material:
 - .1 In accordance with 25/50 flame spread/smoke development ratings when tested in accordance with CAN/ULC-S102 and thickness suiting fire-rating requirements of AHJ.

2.04 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Splitter Damper Hardware:
 - .1 Equal to DynAir (Carlisle).
- .2 Manual Balancing Dampers:
 - .1 Nailor Industries, 1800 Series.
 - .2 T.A. Morrison, TAMCO.
 - .3 Greenheck Fan.
 - .4 NCA Manufacturing.
 - .5 Ruskin.
 - .6 Pottorff.

- .3 Backdraft Dampers:
 - .1 Nailor Industries, 1370CB.
 - .2 T.A. Morrison, TAMCO.
 - .3 Greenheck Fan.
 - .4 NCA Manufacturing.
 - .5 Ruskin.
 - .6 Pottorff.
- .4 Fusible Link Dampers:
 - .1 Nailor Industries.
 - .2 Greenheck Fan.
 - .3 NCA Manufacturing.
 - .4 Ruskin Co.
 - .5 Price Industries (E.H. Price).
 - .6 Pottorff.
- .5 Smoker Dampers:
 - .1 Nailor Industries.
 - .2 Greenheck Fan.
 - .3 NCA Manufacturing.
 - .4 Ruskin.
 - .5 Price Industries (E.H Price).
 - .6 Pottorff.
- .6 Combination Fire and Smoke Dampers:
 - .1 Nailor Industries, Series 1220.
 - .2 Greenheck Fan.
 - .3 NCA Manufacturing.
 - .4 Ruskin.
 - .5 Price Industries (E.H. Price).
 - .6 Pottorff.

3. Execution

3.01 INSTALLATION FOR BALANCING AND OPERATING DAMPERS

- .1 Provide dampers with auxiliary components suiting intended applications.
- .2 Install in accordance with ANSI/SMACNA 006 and manufacturer instructions.
- .3 Install manual balancing dampers providing fully balanced system, including but not limited to open end ductwork, in duct mains, in each branch duct, and for supply, return and exhaust systems.
- .4 Install dampers with operating mechanism accessible and positioned for easy operation, and so dampers cannot move or rattle. Provide operating mechanisms for dampers in insulated ducts with stand-off mounting brackets.

- .5 Where duct for which balancing damper is required has dimensions larger than dimensions of maximum size volume damper available, provide multiple dampers bolted together in properly sized assembly, or bolted to heavy-gauge black structural steel angle or channel framework which is properly sized. Seal preventing air by-pass and provide connecting linkage.
- .6 Install access door adjacent each operating damper.
- .7 Seal multiple damper modules with silicon sealant.
- .8 Runouts to registers and diffusers: Install single blade damper located as close as possible to main ducts.
- .9 Dampers to operate vibration free.
- .10 Install dampers with damper operators in positions observable, operable and accessible.
- .11 Install splitter dampers in supply ductwork at branch duct connections off supply air mains, and wherever else noted.
- .12 Install stand-off mounting brackets for operators for dampers in insulated ducts.
- .13 Install and secure dampers so they cannot move or rattle
- .14 Review and coordinate exact damper locations with results of TAB air quantity balancing testing work.
- .15 Provide [ten] additional balancing dampers in locations as further reviewed with Consultant.

3.02 INSTALLATION FOR FIRE AND SMOKE DAMPERS

- .1 Provide dampers with auxiliary components suiting intended applications.
- .2 Unless otherwise noted, perform installation work in accordance with SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, manufacturer instructions, NFPA 90A and ULC listing.
- .3 Verify damper rating is suitable for fire barrier with which it is associated.
- .4 Install dampers with retaining angles on all four sides of each side of damper, and, where required, connect with ductwork, in accordance with damper manufacturer instructions and details.
- .5 Provide expansion clearance between damper or damper sleeve and opening in which damper is required and in accordance with manufacturer instructions and ULC listings. Prepare openings properly sized and located suiting damper locations. Seal voids between damper sleeve and openings, maintaining rating of fire barrier.
- .6 Maintain integrity of fire separation.
- .7 Install access door adjacent to each damper.
- .8 Coordinate installation of fire stopping materials with requirements of Division 07.
- .9 Install access doors/panels, fusible links, damper operators in locations and positions easily observed and accessible.
- .10 Install break-away joints on each side of fire separation, in accordance with AHJ requirements.
- .11 Seal multiple damper modules with silicon sealant.

- .12 Coordinate provision of electrical connections to damper actuators with electrical work of Division 26.
- .13 Install fire stop flaps in duct connection necks of grilles and diffusers installed in ULC fire-rated suspended ceiling systems, and where noted.
- .14 Install thermal blanket material completely covering grilles and diffuser pans, located above suspended ULC fire-rated ceilings. Cut, install, and secure in place in accordance with manufacturer instructions and ULC listings.

3.03 FIELD QUALITY CONTROL

- .1 When installation is complete, review and inspect installation, test and verify operations.
- .2 Check, test, adjust and verify operation of dampers.
- .3 After completion and prior to concealment, obtain compliance certificate of installation from AHJ.
- .4 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 ASTM International (ASTM):
 - .1 ASTM E84-[21a], Standard Test Method for Surface Burning Characteristics of Building Materials
- .2 National Fire Protection Agency (NFPA):
 - .1 NFPA 90A-[2024], Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-[2024], Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 701-[2023], Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
- .3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA):
 - .1 SMACNA Duct Cleanliness for New Construction Guidelines, [2000].
 - .2 ANSI/SMACNA 006-[2020], HVAC Duct Construction Standards - Metal and Flexible.
 - .3 ANSI/SMACNA 008-[2008], IAQ Guideline for Occupied Buildings Under Construction.
- .4 Underwriters Laboratories (UL):
 - .1 ANSI/UL 181-[Edition 11, 2021], Standard for Factory-Made Air Ducts and Air Connectors.
- .5 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-[2018-REV1], Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S110-[Edition 3,13-R2018], Standard Methods of Tests for Air Ducts.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Indicate:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports.

2. Products

2.01 GENERAL

- .1 Factory Fabrication: In accordance with CAN/ULC-S110 and ANSI/UL 181.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame Spread Rating: Not to exceed 25 as tested in accordance with CAN/ULC-S102.
- .4 Smoke Developed Rating: Not to exceed 50 as tested in accordance with CAN/ULC-S102.
- .5 Not supporting microbial growth.

2.02 TYPE 1 - UNINSULATED FLEXIBLE METALLIC

- .1 Features:
 - .1 SMACNA Form "M-UN".
 - .2 Spiral wound, semi-rigid, self-supporting, corrugated flexible dead soft aluminum with continuous triple lock seams.
 - .3 In accordance with CAN/ULC-S110, Class 1.
 - .4 Supplied in lengths 3 m long.
- .2 Performance:
 - .1 Factory tested to minimum 2.5 kPa without leakage.
 - .2 Rated velocity: Minimum 20 m/s.
 - .3 Maximum Relative Pressure Drop Coefficient: 3.

2.03 TYPE 2 - INSULATED FLEXIBLE METALLIC

- .1 Features:
 - .1 SMACNA Form M-I.
 - .2 Spiral wound, semi-rigid, self-supporting, corrugated flexible dead soft aluminum with continuous triple lock seams.
 - .3 Factory covered with 40 mm, 12 kg/m³ density fibreglass insulation with vinyl jacket with 25/50 flame spread and smoke developed requirements.
 - .4 In accordance with CAN/ULC-S110, Class 1.
 - .5 Supplied in lengths 3 m long.
- .2 Performance:
 - .1 Factory tested to minimum 2.5 kPa without leakage.
 - .2 Rated velocity: Minimum 20 m/s.
 - .3 Maximum Relative Pressure Drop Coefficient: 3.
- .3 Performance:
 - .1 Thermal Resistance: Range options from R4.2 to R8.
 - .2 Maximum Rated Velocity: 20.3 m/s.
 - .3 Maximum Positive Pressure: 3.0 kPa.
 - .4 Maximum Negative Pressure: 0.25 kPa.
 - .5 Temperature Range: Minus 29°C to 122°C.

2.04 TYPE 5 - FLEXIBLE METALLIC ACOUSTIC INSULATED

- .1 Features:
 - .1 Acoustically rated.
 - .2 Core made of perforated dead soft aluminum and manufactured in manner to produce three ply mechanical airtight and leak-proof seams.
 - .3 Corrosive-resistant and puncture-resistant.
 - .4 Core factory wrapped with fiberglass insulation and protected by triple-lock aluminum outer sleeve.
 - .5 Listed in accordance with CAN/ULC S110 as Class 1 air duct.
 - .6 Flame spread rating of not over 25 and smoke developed rating of not over 50.
- .2 Performance:
 - .1 Thermal Resistance: Range options from R4.2 to R8.
 - .2 Maximum Rated Velocity: 20.3 m/s.
 - .3 Maximum Positive Pressure: 1.5 kPa.
 - .4 Maximum Negative Pressure: 0.25 kPa.
 - .5 Temperature Range: Minus 40°C to 204°C.
 - .6 Acoustical performance: Minimum attenuation (dB/m) in accordance with following table:

Duct Diameter	Frequency (Hz)				
	125	250	500	1000	2000
100 mm	0.6	3	12	27	30
150 mm	1.2	3	12	22	27
200 mm	2.0	5	12	19	20
300 mm	2.4	5	12	16	15

2.05 TYPE 6 - FLEXIBLE NON-METALLIC ACOUSTIC INSULATED

- .1 Features:
 - .1 Acoustically rated.
 - .2 Spun-bond non-woven 100% nylon material.
 - .3 Supported by and mechanically bonded to scuff- resistant galvanized external steel helix.
 - .4 Factory applied flexible fiberglass insulation and sleeved with polyethylene vapour barrier.
 - .5 Listed in accordance with CAN/ULC S110 as Class 1 air duct.
 - .6 Flame spread rating of not over 25 and smoke developed rating of not over 50.
- .2 Performance:
 - .1 Thermal Resistance: Range options from R4.2 to R8.
 - .2 Maximum Rated Velocity: 27.9 m/s.
 - .3 Maximum Positive Pressure: 1.5 kPa.
 - .4 Maximum Negative Pressure: 1.2 kPa.
 - .5 Temperature Range: Minus 29°C to 122°C.

- .6 Acoustical Performance: Minimum attenuation (dB/m) in accordance with following table:

Duct Diameter	Frequency (Hz)				
	125	250	500	1000	2000
100 mm	0.6	3	12	27	30
150 mm	1.2	3	12	22	27
200 mm	2.0	5	12	19	20
300 mm	2.4	5	12	16	15

2.06 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Non-metallic Flexible Ducts:
- .1 DuctSox.
 - .2 Flexmaster.
 - .3 Thermaflex.

3. Execution

3.01 DUCT INSTALLATION

- .1 Install in accordance with:
- .1 ANSI/SMACNA 006.
 - .2 ANSI/SMACNA 008.
 - .3 CAN/ULC-S110.
 - .4 NFPA 90A and NFPA 90B.
 - .5 SMACNA Duct Cleanliness for New Construction Guidelines.
- .2 Do not use flexible ducts on healthcare duct work applications or kitchen exhaust duct applications.
- .3 Provide maximum 2 m long lengths of flexible ductwork for connections between galvanized steel duct mains and branches, and necks of ceiling grilles and diffusers. Install with long radius bends. Do not install flexible ductwork through walls.
- .4 At rectangular galvanized steel duct, accurately cut holes and provide flanged or "spin-in" round flexible duct connection collars. Seal joints with duct sealer.
- .5 Install flexible ducts as straight as possible and support in position. Secure at each end with nylon or stainless steel gear type clamps, and seal joints. Provide long radius duct bends where they are required.
- .6 Do not penetrate fire barriers with flexible duct.
- .7 Fabric Ductwork:
- .1 Secure duct from structure by means of tension cable and suspension components supplied with ductwork.
 - .2 Install tension cable and suspension components in accordance with duct manufacturer instructions.

- .3 Provide metal duct connection collars as required.
- .4 Start-up fabric duct system in accordance with manufacturer instructions.

3.02 FIELD QUALITY CONTROL

- .1 When installation is complete, review and inspect installation, test and verify operations.
- .2 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 Air Movement and Control Association International (AMCA):
 - .1 AMCA Publication 211-[13(Rev. 10-18)], Certified Ratings Program - Product Rating Manual for Fan Air Performance.
 - .2 AMCA Publication 311-[16], Certified Ratings Program Product Rating Manual for Fan Sound Performance.
- .2 American National Standards Institute/Air Movement and Control Association International (ANSI/AMCA):
 - .1 ANSI/AMCA Standard 99-[16], Standards Handbook.
 - .2 ANSI/AMCA Standard 204-[20], Balance Quality and Vibration Levels for Fans.
 - .3 ANSI/AMCA Standard 210-[16]/ASHRAE 51-[16], Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
 - .4 ANSI/AMCA Standard 300-[14], Reverberant Room Method for Sound Testing of Fans.
 - .5 ANSI/AMCA Standard 301-[14], Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .3 ASTM International (ASTM):
 - .1 ASTM A1011/A1011M-[18a], Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- .4 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-[Edition 8, 2018-REV1], Standard Method of Test for Surface Burning Characteristics of building Materials and Assemblies.
- .5 Underwriters Laboratories (UL):
 - .1 ANSI/UL 507-[2023], Electric Fans.
 - .2 ANSI/UL 705-[2022], Power Ventilators.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Submit and Identify:
 - .1 Fan performance curves showing point of operation, kW and efficiency.
 - .2 Sound rating data at point of operation.
 - .3 Motors, sheaves, bearings, shaft details.

- .4 Minimum performance achievable with, as appropriate, variable inlet vanes and variable speed controllers.
- .5 Method of anchorage.
- .6 Number of anchors.
- .7 Supports.
- .8 Reinforcement.
- .9 Assembly details.
- .10 Accessories.
- .11 Indicate electrical characteristics including make and model number.
- .12 Power and control diagrams.
- .13 Recommended maintenance materials.
- .3 Submit testing and verification reports.

2. Products

2.01 PERFORMANCE REQUIREMENTS:

- .1 Catalogued or published ratings for manufactured items: Obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
- .2 Capacity: Flow rate, static and total pressure, wattage, efficiency, revolutions per minute, power, model, size, sound power data and as noted.
- .3 Fans: Statically and dynamically balanced, constructed in accordance with ANSI/AMCA Standard 99.
- .4 Sound Ratings: Certified with AMCA seal in accordance with AMCA Publication 311 and ANSI/AMCA Standard 301, and tested in accordance with ANSI/AMCA Standard 300.
- .5 Air Performance Ratings: Certified with AMCA seal in accordance with AMCA Publication 211 and based on tests performed in accordance with ANSI/AMCA Standard 210/ASHRAE 51.
- .6 Fan Efficiency Ratings: In accordance with AMCA Standard 205.
- .7 Operate over complete pressure class limits in accordance with ANSI/AMCA Standard 99.

2.02 FANS - GENERAL

- .1 Standards of entire fan assemblies:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 In accordance with ANSI/UL 705.
- .2 Fan Drives: Direct-drive or belt-drive as noted, suiting intended applications.
- .3 Motors:
 - .1 In accordance with Section 26 05 80 - Motors and supplemented as noted.
 - .2 For use with variable speed controllers.
 - .3 Sizes as noted.
 - .4 Two speeds with two windings and speeds of approximately as noted.

- .5 Two speeds with split winding, constant horsepower, constant or variable torque and speeds, as noted.
- .4 Factory primed before assembly in colour standard to manufacturer.
- .5 Finish on fume hood exhaust fans: As reviewed with Consultant.
- .6 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .7 Maximum acceptable sound power levels at fan outlets: As noted and as reviewed with Consultant.
- .8 Accessories and Hardware (fan manufacturer factory supplied):
 - .1 Matched sets of V-belt drives, motor bases, belt guards, coupling guards fan inlet/outlet safety screens.
 - .2 Inlet/outlet dampers and vanes.
 - .3 Scroll casing drains.
 - .4 Shaft Grounding Ring:
 - .1 When fan controlled by variable frequency drive.
 - .2 Conductive ring stays in continuous contact with motor shaft collecting stray currents and shunts them to frame ground.
 - .5 Stainless steel exhaust grille.
 - .6 Enamel painted aluminum exhaust grilles.
 - .7 Rectangular to round duct transitions.
 - .8 Roof caps with backdraft dampers and bird screens.
 - .9 Wall caps with backdraft dampers and bird screens.
 - .10 Flexible Connections: Refer to Section 23 33 00 - Air Duct Accessories.
 - .11 Controls:
 - .1 Speed Controls:
 - .1 Controls fan output.
 - .2 Adjust fan to 60 percent of full speed.
 - .3 Operate more than one fan at a time.
 - .2 Time Delay Switches: Automatically turns fans off after preset time delay.
 - .3 Motion Detectors.
- .9 Seismic Restraints: Factory secured seismic restraint connection hardware in accordance with Division 13 or Section 23 05 48 - Vibration and Seismic Controls for HVAC.

2.03 CENTRIFUGAL INLINE FANS

- .1 General:
 - .1 Centrifugal type, factory run tested, inline fans.
 - .2 Rectangular.
- .2 Construction:
 - .1 Housings:
 - .1 Locked-seam galvanized steel, [continuously welded heavy-gauge galvanized steel] [stainless steel] [aluminum] housing.
 - .2 Removable side access panels permitting removal of power assembly without disturbing duct connections.

- .3 Stainless steel nameplates.
- .2 Universal mounting brackets and hardware.
- .3 Spring vibration isolators accommodate horizontal or vertical mounting suiting intended applications.
- .4 Flanged inlet panel with inlet venturi, flanged outlet panel, both with duct connection collars.
- .5 Galvanized steel wire grid fan inlet/outlet guards and drain plug.
- .3 Drives:
 - .1 Direct-Drives:
 - .1 Coupling with service factor of 1.5 x motor HP between motor and fan shaft.
 - .2 OSHA compliant coupling guard.
 - .2 Belt-Drives:
 - .1 Drive Components:
 - .1 V-belt drive, rated for minimum 150 percent of motor nameplate horsepower.
 - .2 Machined, fixed or adjustable pitch (suiting intended applications) cast-iron pulleys:
 - .1 Motor 10 HP and Smaller: Adjustable pitch.
 - .2 Motor 15 HP and Larger: Fixed pitch.
 - .3 Heat resistant, oil resistant, static-free V-belts.
 - .2 Belt Guards:
 - .1 Steel, ventilated, OSHA compliant.
 - .2 Quick access designed with hinged front and rubber latches.
- .4 Fan Wheels:
 - .1 Materials of Construction: Aluminum or welded steel wheel of manufacturer standard, based on wheel size and pressure class.
 - .2 Statically and dynamically balance wheel.
 - .3 Minimum Balance Quality Grade: G6.3, in accordance with AMCA Standard 204.
 - .4 Wheel removal through fan inlet opening.
 - .5 Blades:
 - .1 Airfoil:
 - .1 Fabricated wheel with airfoil type blades, continuously welded to flat trim and backplate.
 - .2 Hub keyed to shaft.
 - .3 Partial welds not acceptable.
 - .2 Backward Inclined:
 - .1 Fabricated wheel with flat, single thickness blades, continuously welded conical rim and backplate.
 - .2 Hub keyed to shaft.
 - .3 Partial welds not acceptable.
 - .3 Forward Curved: Die-formed steel wheels riveted to wheel cone and backplate.
- .5 Fan Shafts and Bearings:

- .1 AISI C1040 or AISI C1045 hot rolled steel shaft, accurately turned, ground, and polished, and ring gauged for accuracy.
- .2 Shaft sized for first critical speed of at least 1.43 times maximum rated speed for fan.
- .3 Petroleum based rust prevention coating on shaft.
- .4 Key shaft to wheel hub.
- .5 Shaft Seals: Constructed of woven fibrous compressed between aluminum cover plate and fan housing.
- .6 Bearings:
 - .1 Heavy-duty, grease lubricated, spherical roller or anti-friction ball, self-aligning, pillow block type bearings.
 - .2 Selected for minimum ABMA L-10 bearing life of 100,00 hours at maximum fan RPM.
 - .3 Secured to bearing support platform.
- .7 Copper or aluminum lubrication line and fittings, terminated immediately inside fan section access door.
- .8 OSHA compliant shaft and bearing guards.
- .6 Motors:
 - .1 NEMA Premium TEFC motor sized as noted, with V-belt selected for 40% service factor based on motor nameplate data.
 - .2 In accordance with Section 26 05 80 - Motors.
 - .3 Mounted out of airstream, complete with cover/guard.
 - .4 When controlled with variable frequency drive, provide premium efficiency motors suitable for inverter duty use.
 - .5 Factory pre-wired to NEMA 4 disconnect switch.
- .7 Fan and Motor Support Base:
 - .1 Rigid, welded structural steel, vibration isolated base with steel cross members.
 - .2 Factory cleaned, deburred, and finished with epoxy enamel.
 - .3 Slide type motor base and stable, colour coded spring mounts with sound pads selected suiting static deflection and maximum equipment load and operating at not greater than 2/3 solid load, and shipping restraints.
- .8 Finishes:
 - .1 Prior to assembly, rust inhibiting primer applied to cleaned and deburred metal surfaces.
 - .2 Second coat of primer after assembly and air-dried epoxy enamel finished coat both inside and outside to 3 mm dry film thickness.
- .9 Accessories:
 - .1 Flexible Duct Connections. Elastomer round and rectangular flexible connection assemblies with duct flanges matching fan outlet connections.
 - .2 Outlet flanges with pre-punched bolt holes.
 - .3 Outlet Companion Flanges: Slip-on flanges matching fan housing flange size and bolt-hole pattern.
 - .4 Drain with Plug: Threaded pipe coupling, 3/4 inch NPT, welded to lowest point on housing scroll.

- .5 Inlet Boxes:
 - .1 Match housing construction with integral configuration with fan housing.
 - .2 Access doors.
 - .3 Drains with plugs.
 - .4 Housing with insulation of minimum thickness 50 mm anchored with weld pins.
- .6 Volume Control Devices:
 - .1 Inlet Vane Dampers.
 - .2 Outlet Dampers.
 - .3 Inlet Box Dampers.
- .7 Actuators:
 - .1 Electric.
 - .2 Double acting pneumatic actuator (air-to-air).
 - .3 Pneumatic actuator with spring return (air-to-spring).
- .8 Safety Screens: At inlets and outlets.
- .9 Flow Metering Provisions: Piezometer ring type differential pressure device with connections for field-installed flow measuring instrumentation pressure transducer with transmitter and display of 4 to 20 mA DC signal proportional to flow.
- .10 Vibration and Seismic Controls: Refer to article – FANS - GENERAL above.

2.04 SIDEWALL PROPELLER FANS

- .1 General:
 - .1 Axial flow type, factory run tested propeller fans.
 - .2 Stainless steel nameplates.
- .2 Construction:
 - .1 Heavy-gauge galvanized steel drive component frame bolted or welded to formed galvanized steel fan panel equipped with formed flanged edges, pre-punched mounting holes, and deep formed inlet venturi.
 - .2 Fabricated steel blades, welded to heavy-gauge steel hub, and dynamically balanced.
- .3 Belt-Drive Fans:
 - .1 Fan Shafts and Bearings:
 - .1 AISI C1045 hot rolled steel shaft, accurately turned, ground, and polished, and ring gauged for accuracy.
 - .2 Shaft sized for first critical speed of at least 1.25 times maximum rated speed for fan.
 - .3 Petroleum based rust prevention coating on shaft.
 - .4 Bearings: Heavy-duty, grease lubricated, ball, pillow block type bearings, selected for minimum ABMA L-10 bearing life of 100,00 hours at maximum fan RPM, and secured to bearing support platform.
 - .5 Extended copper or aluminum lubrication line and fittings.
 - .2 V-belt Drive: Machined, adjustable pitch cast-iron pulleys.
 - .3 Belt Guard:

- .1 Steel, ventilated, OSHA compliant.
 - .2 Quick access designed with hinged front and rubber latches.
- .4 Motors:
 - .1 NEMA Premium TEFC motor with variable pitch adjustable V-belt drive with guard.
 - .2 In accordance with Section 26 05 80 - Motors.
- .5 Finish: Cleaned, primed, and factory finished with epoxy equipment enamel.
- .6 Factory supplied accessories for fans as noted and suiting intended applications:
 - .1 16 gauge G90 galvanized steel wall box with removable screen guard, equipped with mounting flanges with pre-punched holes.
 - .2 Back draft damper with galvanized steel frame, aluminum blades with felt edge seals, stainless steel shaft, and OSHA damper guard.
 - .3 Galvanized steel weather hood with removable galvanized steel wire mesh bird screen, with mounting flanges equipped with pre-punched mounting holes.
 - .4 OSHA motor side guard with galvanized steel side panels and removable galvanized steel wire mesh screen.
- .7 Vibration and Seismic Controls: Refer to article – FANS - GENERAL above.

2.05 DUCT BLOWERS / CABINET FANS

- .1 Standards:
 - .1 ANSI/UL 705.
 - .2 CSA certified.
 - .3 AMCA Certified Ratings Seal for Sound and Air.
- .2 Types:
 - .1 Single Double Width, Double Inlet (DWDI) forward curved blower assembly with motor located in air stream.
 - .2 Two Double Width, Double Inlet (DWDI) forward curved blower assemblies with common shaft and single motor located in air stream.
 - .3 Single Double Width, Double Inlet (DWDI) forward curved blower assembly with motor located out of air stream.
 - .4 Single Double Width, Double Inlet (DWDI) backward inclined blower assembly with motor located out of air stream.
- .3 Fans:
 - .1 Duct mounted, belt driven centrifugal cabinet fans.
 - .2 Refer to requirements specified for centrifugal fans.
 - .3 Bolted construction utilizing corrosion resistant fasteners.
 - .4 Housing of minimum 18 gauge galvanized steel with access doors to interior of housing and integral duct collars.
 - .5 Blower and motor assembly mounted on rubber vibration isolators.
 - .6 Hanging brackets provided for horizontal installation.
- .4 Wheels:
 - .1 DWDI centrifugal.

- .2 Forward curved: Constructed of painted steel.
- .3 Backward included: Constructed of 100% aluminum, including precision machined cast aluminum hub. Wheel inlet overlaps aerodynamic aluminum inlet cone.
- .4 Balanced in accordance with ANSI/AMCA Standard 204.
- .5 Nameplates:
 - .1 Engraved aluminum or stainless steel nameplates.
 - .2 Identification of design m³/minute (CFM), static pressure and maximum fan RPM.
- .6 Motors:
 - .1 NEMA Premium TEFC motor with V-belt drive with guard.
 - .2 In accordance with Section 26 05 80 - Motors.
 - .3 Bearings:
 - .1 Designed and individually tested specifically for use in air handling applications.
 - .2 Permanently lubricated, sealed ball type selected for minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- .7 Belts and Drives:
 - .1 Belts: Oil and heat resistant, non-static type.
 - .2 Drives:
 - .1 Precision machined cast iron type, keyed and securely attached to wheel and motor shafts.
 - .2 Sized for 150% of installed motor horsepower.
 - .3 Variable pitch motor drive factory set to specified fan RPM.
- .8 Accessories:
 - .1 Disconnect Switches: NEMA rated types suiting specific applications.
 - .2 Filters.
 - .3 Flexible duct collars.
 - .4 Backdraft dampers: Types suiting intended applications.
 - .5 Spring isolators: Types suiting intended applications.
- .9 Vibration and Seismic Controls: Refer to article – FANS - GENERAL above.

2.06 CEILING-MOUNTED EXHAUST FANS

- .1 General:
 - .1 Ceiling-mounted centrifugal exhaust fans.
 - .2 AMCA rated and certified.
 - .3 Above Bathtubs/Shower Applications: ULC listed and labeled for such applications and connected to ground fault circuit interrupter.
 - .4 Stainless steel nameplates.
- .2 Housings:
 - .1 Minimum 20 gauge galvanized steel housing.
 - .2 Duct connection collars and integral spring-loaded aluminum backdraft damper.

- .3 Minimum 12 mm thick acoustic insulation meeting 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC-S102.
- .4 Multi-position mounting brackets.
- .5 Power Receptacles: CSA certified electrical receptacle in outlet box for plug-in connection of fan motor.
- .6 Fan Wheel and Motor Assemblies:
 - .1 Low RPM, resiliently mounted, direct connected fan wheel and motor assembly.
 - .2 Forward curved centrifugal wheel, statically and dynamically balanced.
 - .3 Galvanized steel or calcium carbonate filled polypropylene wheel.
 - .4 Sound levels as low as 0.7 AMCA sones.
 - .5 1-phase electronically commutated motor (ECM) motor equipped with suitable length of power cord and plug set.
 - .6 Motor enclosures: Open drip-proof (ODP), opening in frame body or end brackets.
 - .7 Motor mounted on vibration isolators and be accessible for maintenance.
 - .8 Motor equipped with thermal overload protection.
- .7 Spring Loaded Aluminum Backdraft Damper:
 - .1 Prevents air from entering back into building when fan is off.
 - .2 Eliminates rattling or unwanted backdrafts.
- .8 Grille Types: As noted:
 - .1 Decorative: Constructed of high impact polystyrene.
 - .2 Aluminum.
 - .3 Stainless steel.
- .9 Accessories:
 - .1 Mounting brackets.
 - .2 Lighting units.
 - .3 Speed Controls:
 - .1 Controls fan output.
 - .2 Adjust fan to 60 percent of full speed.
 - .3 Operate more than one fan at a time.
 - .4 Time Delay Switches:
 - .1 Save energy by automatically turning off fan.
 - .2 Delay of 1 to 60 minutes after fan light turned off.
- .10 Vibration and Seismic Controls: Refer to article – FANS - GENERAL above.

2.07 CEILING MOUNTED DESTRATIFICATION FANS

- .1 General:
 - .1 CSA certified, direct drive ceiling mount destratification fans.
 - .2 Diameters up to 1.5 m, with specific sizes as noted.
 - .3 In accordance with ANSI/UL 507.
 - .4 Stainless steel nameplates.
- .2 Features:
 - .1 White finish, extra heavy-duty industrial grade.

- .2 Down blowing, up blowing or reversing: As noted.
- .3 All metal construction.
- .4 Triple neoprene seals: Neoprene deflection boot, neoprene sealed motor case, and twist lock cap on neoprene sealed down rod.
- .5 Corrosion resistant prime and finish coats on metal housings and blades.
- .6 Curved aluminum fan blades, each secured to steel hub with minimum 2 high strength locking bolts.
- .7 Motors:
 - .1 Totally enclosed, permanent magnet, brushless, non-ventilated, heat sink design motor rated for continuous operation at maximum speed in 55°C ambient temperature.
 - .2 Capable of modulating fan speed from 0 to 100% without use of gearbox or other mechanical means of control.
 - .3 Thermal protection.
 - .4 Permanent, sealed chrome ball bearings.
 - .5 One way condensation release plug installed on bottom of motor housing.
 - .6 Cast iron motor housing.
- .8 Controller:
 - .1 Factory programmed controller housed in enclosure independent of motor minimizing starting and braking torques.
 - .2 Simple diagnostic program and LED to identify and relay faults in system.
- .9 Supports:
 - .1 250 mm long down rods.
 - .2 330 mm long galvanized steel safety chain.
 - .3 Mounting and securing brackets and hardware.
- .3 Accessories:
 - .1 Power Wiring (as noted suiting intended applications):
 - .1 Cord: 400 mm long power cord with 3-prong plug, factory pre-wired to motor.
 - .2 Hard wired.
 - .2 Fan Guard: Welded wire fan guard sized suiting fan blade size.
 - .3 Fan Speed Controllers:
 - .1 120 volts variable speed (Off-High-Low) solid-state infinite speed fan controller.
 - .2 Stainless steel faceplate designed to mount to 100 mm outlet box.
 - .3 Controls fan groupings as noted.
- .4 Vibration and Seismic Controls: Refer to article – FANS - GENERAL above.

2.08 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Centrifugal, explosion-proof, utility, ceiling, roof mounted, sidewall, vane-axial, filtered supply, cabinet and plenum fans:
 - .1 Twin City Fan and Blower.
 - .2 Loren Cook.

- .3 Greenheck Fan.
- .4 CML Northern Blower.
- .5 PennBarry.
- .6 JencoFan.
- .7 Carnes Company Inc.
- .2 Corrosion Resistant Centrifugal Fans:
 - .1 M.K. Plastics.
 - .2 New York Blower.
 - .3 Pasticair.
- .3 Ceiling Mounted Destratification Fans:
 - .1 Northwest Envirofan.
 - .2 Big Ass Fan.
 - .3 Marley Engineered Products.
- .4 Lab Exhaust (High Plume) Fans:
 - .1 Loren Cook.
 - .2 Strobic.
 - .3 Greenheck.
 - .4 MK Plastic.

3. Execution

3.01 INSTALLATION OF FANS

- .1 Provide fans, with resilient mountings, flexible electrical leads and flexible connections, suiting intended applications.
- .2 Coordinate with structural engineer as required to verify mounting structures for fans are able to support weight and operational torque of fans.
- .3 Coordinate installation of roof mounting fans with roofing trades verifying mounting structures for fans support weight and operational torque of fans. Coordinate and review installation with roofing trades and obtain acceptance of installation and roof penetrations.
- .4 Secure each fan in place, level and plumb. Secure base mounted fans on vibration isolation on concrete housekeeping pad or base.
- .5 Secure suspended units in place from structure, level and plumb, by means of vibration isolation spring hangers, properly sized galvanized steel hanger rods and galvanized structural steel angle or channel trapeze supports.
- .6 Wall-Mounted Fans: Coordinate locations and sizes of wall openings with trade preparing openings. Rigidly secure each fan and accessories in place to structure in accordance with fan manufacturer instructions.
- .7 Make duct connections using factory supplied companion flanges and flexible connection material.
- .8 Provide sheaves and belts required for final air balance.
- .9 Install such that bearings and extension tubes are easily accessible.

- .10 Install such that access doors, access panels and connecting ducts are easily accessible for service and maintenance.
- .11 Secure ceiling-mounted exhaust fan housing in place in ceiling space, flush with suspended ceiling. Secure suspended units in place from structure, level, and plumb, by means of vibration isolation spring hangers and galvanized steel hanger rods. Plug fan motors into housing receptacles.
- .12 Supply exterior wall/roof discharge caps as noted. Hand roof caps to roof trade for installation and flashing into roof construction as part of roofing work. Install caps and secure in place. Caulk perimeter of each wall cap in accordance with caulking requirements of Division 07. Coordinate flashing and sealing of roof caps with trade providing roof work. Connect fan housings and discharges with ductwork. Coordinate with work of Division 07.
- .13 Coordinate connection of power to fans, and from fan starters to damper motors, with electrical work of Division 26.
- .14 Ground and bond equipment.
- .15 Brace and secure each unit in accordance with vibration and seismic requirements. Size anchor bolts to withstand seismic acceleration and velocity forces as noted.

3.02 INSTALLATION OF CEILING MOUNTED DESTRATIFICATION FANS

- .1 Prior to ordering, review fan finishes and sizes with Consultant.
- .2 Install fans in locations after ceiling finishes are complete. Prior to roughing-in, review locations with Consultant.
- .3 Coordinate with structural engineer verifying mounting structures for fans support weight and operational torque of fans.
- .4 Verify that fan locations are free from obstacles such as lights, cables, or other building components. Mount fans at least 3050 mm above floor and at least 610 mm free of obstructions such as lights, cables, sprinklers, or other building structures.
- .5 Provide rigid, wire guard for each fan as noted and secure in place.

3.03 INSTALLATION OF CONTROLS

- .1 Provide controls as noted and reviewed with Consultant. Coordinate responsibilities between trades. Provide controls wiring. Coordinate with requirements of Division 25.
- .2 Confirm exact speed controller locations prior to installation and include for identification of each speed controller.
- .3 Install rectangular or square outlet box at controller mounting location.
- .4 Supply fan speed controller for fans as noted and hand to electrical trade at site for wall mounting and connection to fan motor controllers.
- .5 Coordinate locations of controllers and verify controllers are mounted to flat, readily accessible surface that is free from vibration and away from foreign objects and moving equipment.

3.04 FIELD QUALITY CONTROL

- .1 Inspection, Start-Up, Testing and Verification:
 - .1 In accordance with manufacturer recommendations.
 - .2 Field inspect and test each fan, motor, and controllers.

- .3 Check for safe and proper operation.
 - .4 Verification of proper installation, making adjustments and fine tuning, and performing system initiation startup.
 - .5 Verify that units are secured to supports and that duct and electrical connections are complete. Verify that proper thermal-overload protection is installed in motors, starters and disconnect switches.
 - .6 Verify that cleaning and adjusting are complete.
 - .7 Disable automatic temperature-control actuators, energize motor, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - .8 Shut unit down and reconnect automatic temperature-control actuators.
 - .9 Remove and replace malfunctioning units and retest as specified above.
 - .10 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - .11 Verify proper motor rotation direction. Verify fan wheel free rotation and smooth bearing operation. Align and adjust belts, and install belt guards.
 - .12 Verify that manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in fully open position.
- .2 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
 - .1 AHRI 410-[2023], Performance Rating of Forced-Circulation Air-Cooling and Air-Heating Coils.
 - .2 AHRI Standard 881-[2017], Performance Rating of Air Terminals.
- .2 American National Standards Institute/Air Movement and Control Association International, Inc (ANSI/AMCA):
 - .1 ANSI/AMCA Standard 210-[16]/ASHRAE 51-[16], Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - .1 ANSI/ASHRAE Standard 130-[2016], Laboratory Methods of Test for Air Terminal Units.
- .4 International Organization for Standardization (ISO):
 - .1 ISO 3741-[2010], Acoustics - Determination of Sound Power Levels and Sound Energy Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Test Rooms.
- .5 National Fire Protection Association (NFPA):
 - .1 NFPA 90A-[2024], Standard for the Installation of Air-Conditioning and Ventilating Systems.
- .6 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-[Edition 8, 2018-REV1], Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .7 Underwriters Laboratories (UL):
 - .1 UL 1995-[2015], Heating and Cooling Equipment.
 - .2 UL 94-[2023], Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Submit test data made by independent testing agency with:
 - .1 ANSI/AMCA Standard 210 requirements.
 - .2 Published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 for 0, 2.5 and 6 m/s branch velocity or inlet velocity.
 - .3 Sound power level with minimum inlet pressure of 0.25 kPa in accordance with ISO 3741 for 2nd through 7th octave band.

- .4 Confirmation that pressure loss through silencer does not exceed 60% of inlet velocity pressure maximum.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Identify:
 - .1 Capacity and pressure drop.
 - .2 Sound power data verifying conformance with specified sound power levels.
 - .3 Leakage and dimensions.
 - .4 Mounting details suiting installed locations, and indicating methods and hardware used.
 - .5 Control components and control wiring schematic.
 - .6 Sequence of operation for equipment and controls.
- .3 Submit following samples:
 - .1 [].
- .4 Submit site inspection and start-up report from manufacturer representative and coordinated with controls work of Division 25.
- .5 Submit manufacturer compliance certificates certifying that materials comply with specified performance characteristics and physical properties.
- .6 Submit compliance certificates, and testing and verification reports.

1.03 QUALITY ASSURANCE

- .1 Air terminals Manufacturers: Current members of Air-Conditioning, Heating and Refrigeration Institute (AHRI).

2. Products

2.01 GENERAL

- .1 Terminal Units: In accordance with:
 - .1 AHRI Standard 881.
 - .2 ANSI/AMCA Standard 210.
 - .3 ISO 3741.
- .2 Product Type: As noted. Include following:
 - .1 Sizes and capacities (minimum and maximum air flow).
 - .2 Differential pressures, pressure loss, sound ratings and discharge sound pressure levels.
 - .3 Silencers, attenuators, inlet duct connections, duct shape and duct size.
 - .4 Dampers, controllers and operators.
 - .5 Component locations.
- .3 Dampers: As noted, and specified in Section 23 33 13 - Dampers.
- .4 Silencer/Liners:
 - .1 As noted.

- .2 In accordance with Section 23 32 48 - Silencers and Acoustical Air Plenums.
- .3 In accordance with Section 23 33 53 - Duct Liners.
- .5 Reheat Coils:
 - .1 As noted.
 - .2 In accordance with Section 23 82 35 - Reheat Coils.
- .6 Include mounting and connection accessories, suiting mounting location and application.
- .7 Provide terminal units of same type from same manufacturer.
- .8 Exposed cut edges of liner material: Factory coated with sealant in accordance with NFPA 90A and CAN/ULC-S102.
- .9 Provide terminal boxes complete with attenuator or lined discharge duct in place. Provide maximum sound power levels in decibels and specific static pressure requirements as noted for each size of box.
- .10 Equip boxes with factory secured seismic restraint connection hardware in accordance with seismic restraint requirements

2.02 VARIABLE AIR VOLUME (VAV) BOXES

- .1 Single duct, controller type, pressure independent variable air volume boxes, each individually field adjustable to minimum and maximum air volumes.
- .2 Unit Casings:
 - .1 Constructed of minimum 0.816 mm thick galvanized steel.
 - .2 Assembled with longitudinal lock seam construction.
 - .3 Leakage tested in accordance with ANSI/ASHRAE Standard 130.
 - .4 Leakage for basic assembly not to exceed 1.0 percent of maximum rated airflow at 249 Pa of water gauge.
 - .5 Leakage for basic assembly not to exceed 2.0 percent of maximum rated airflow at 749 Pa of water gauge.
- .3 Housings:
 - .1 No. 22 gauge galvanized steel housing, assembled with longitudinal lock seam construction sealed and gasketed.
 - .2 50 mm long, round inlet duct connection.
 - .3 Rectangular discharge opening with slip and drive cleat duct connection facilities.
 - .4 Protective galvanized steel shroud for controller and damper actuator.
- .4 Linings:
 - .1 Internally lined with 25 mm thick glass fibre duct lining material with neoprene coating.
 - .2 Internally lined with 25 mm thick fibre-free foam lining material.
 - .3 Internally lined with 25 mm thick aluminium foil faced glass fibre lining material
 - .4 In accordance with NFPA 90A and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC-S102.
 - .5 Exposed cut edges of liner material: Factory coated with sealant in accordance with NFPA 90A and CAN/ULC-S102.
- .5 Air Valve Dampers:

- .1 Normally open, galvanized steel blade with peripheral gasket.
- .2 Pivoting in self-lubricating bearings.
- .3 Air leakage past closed damper of 2% or less of rated capacity at 750 Pa inlet static pressure.
- .4 Damper Shafts:
 - .1 Incorporate visual position indicator etched into end of damper shaft, clearly indicating damper position over full range of 90 degrees.
 - .2 Mounted on left, right, top or bottom as noted, of damper when looking in direction of airflow. Exact positions confirmed with Consultant.
 - .3 18 gauge damper assembly incorporates peripheral gasket on damper blades for tight airflow shutoff.
 - .4 Damper, seal, and bearing systems: Tested to 1.25 million cycles, or equivalent of 100 full open/closures per day for 35 years, with no visible signs of wear, tear, or failure of damper assembly after such testing.
- .6 Air Flow Sensors:
 - .1 Located at box inlet, complete with gauge taps and multiple pressure-sensing ports.
 - .2 Averaging chamber designed to accurately average flow across inlet of box with accuracy of within 5% with 90° sheet metal elbow located directly at inlet, and amplify sensed air flow signal.
 - .3 Differential pressure airflow device measuring total and static pressures, and mounted to inlet valve.
 - .4 Fire-resistant plastic parts in accordance with UL 94.
 - .5 RoHS (Restriction of Hazardous Substances) compliant.
 - .6 Control tubing protected by grommets at wall of airflow sensor housing.
 - .7 Include:
 - .1 Twelve total pressure sensing ports and four static pressure sensing ports.
 - .2 Center averaging chamber that amplifies sensed airflow signal.
 - .3 Polyethylene tubes, connectors and accessories.
 - .8 Airflow sensor signal accuracy: After balancing, plus or minus five percent throughout terminal operating range.
- .7 Controllers, Thermostats and Actuators:
 - .1 Provided under controls work of Division 25:
 - .1 Controllers/actuators:
 - .1 Shipped to terminal box manufacturer plant by controls supplier.
 - .2 Factory installed and connected by box manufacturer.
 - .2 Provided with terminal boxes:
 - .1 Pneumatic controllers/actuators:
 - .1 Factory installed and connected.
 - .2 Field adjustable controller and suitable pneumatic actuator for damper.
 - .3 Factory calibrated and set for minimum and maximum air flow rates noted.
 - .4 Gauge taps for balancing with standard pressure gauges.

- .2 Electronic controllers/actuators:
 - .1 Factory installed, connected and tested control package.
 - .2 Electronic controllers, electronic flow transducers, and electronic actuator for dampers.
 - .3 Factory calibrated and set for maximum and minimum air flow, and field adjustable.
 - .4 Gauge taps for balancing with standard pressure gauges.
- .3 Digital controllers/actuators:
 - .1 Factory installed, connected and tested control package.
 - .2 Microprocessor based stand-alone digital controller with BMS/BAS networking interfacing.
 - .3 Portable operator interface device.
 - .4 Electronic flow transducer and electronic actuator for dampers.
 - .5 Factory calibrated and set for maximum and minimum air flow, field adjustable.
 - .6 Gauge taps for balancing with standard pressure gauges.
- .4 Thermostats:
 - .1 Wall mounting thermostat with thermometer and guard.
 - .2 Operations suiting box it controls and control sequence.
 - .3 Installation and connection accessories.
- .5 Where integrated to BMS/BAS, compatible with Division 25 BMS/BAS communications protocols. Coordinate with controls work of Division 25.
- .8 Attenuators:
 - .1 Galvanized steel discharge attenuators, lined in accordance with box housings.
 - .2 Factory supplied loose and with length as noted.

2.03 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Air Terminal Boxes:
 - .1 Price Industries.
 - .2 Titus.
 - .3 Nailor Industries.
 - .4 Krueger Division of Air System Components.

2.04 INSTALLATION

- .1 Install terminal units and support independently of ductwork.
- .2 Install with at least 1000 mm of flexible inlet ducting and minimum of four duct diameters of straight inlet duct, same size as inlet.
- .3 Locate controls, dampers and access panels for easy access for servicing and maintenance.
- .4 Install terminal boxes ceiling mounted in locations as noted.
- .5 Secure each box in place from structure by means of galvanized steel angles and hanger rods, independent of connecting ductwork.
- .6 Brace and secure each unit in accordance with specified seismic restraint requirements.

- .7 Coordinate provision of controllers, thermostats, transformers or actuators with work of Division 25.
- .8 Provide sequence of operation of equipment. Coordinate with controls work of Division 25.
- .9 Provide control wiring in conduit in accordance with manufacturer control wiring schematics and electrical wiring standards Division 26. Coordinate BMS/BAS interconnection wiring with work of Division 25.
- .10 Connect each box with ductwork. Provide straight inlet duct same size as box inlet and of length equal to minimum of 4 duct diameters. Coordinate final box adjustments and settings with personnel doing system testing and balancing work.
- .11 Ensure damper operator attached to assembly allows full modulation of flow range from 100 percent of design flow to zero.

2.05 FIELD QUALITY CONTROL

- .1 Prepare sequence of operation for equipment and controls and submit to Consultant for review and recommendations for acceptance.
- .2 Inspection, Start-Up, Testing and Verification Work:
 - .1 In accordance with manufacturer recommendations.
 - .2 Field inspect and test equipment and control units.
 - .3 Check for safe and proper operation. Check for proper sequence of operations.
 - .4 Remove and replace malfunctioning units and retest as specified above.
 - .5 Test and adjust controls and safeties.
 - .6 Verification of proper installation, adjustment, fine tuning and system initiation.
 - .7 Verify that units are secured to supports, and that duct and electrical connections are complete.
 - .8 Verify that cleaning and adjusting is complete.
- .3 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/Sheet Metal and Air Conditioning Contractors' National Association (ANSI/SMACNA):
 - .1 ANSI/SMACNA 006-[2020], HVAC Duct Construction Standards - Metal and Flexible.
- .2 American National Standards Institute/The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ANSI/ASHRAE):
 - .1 ANSI/ASHRAE Standard 70-[2006(RA-2011)], Method of Testing the Performance of Air Outlets and Air Inlets.
- .3 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-[2018-REV1], Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S112-[2010-R2021], Standard Methods of Fire Test of Fire-Damper Assemblies.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Indicate following:
 - .1 Capacities.
 - .2 Throw and terminal velocities.
 - .3 Noise criteria.
 - .4 Pressure drops.
 - .5 Neck velocities.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit manufacturer colour chart from which finish colour is selected.
- .4 Grilles and diffusers with integral volume control dampers: Supply minimum of ten identified (with tags) grille/diffuser volume control damper adjustment keys.
- .5 Submit samples of each type of following:
 - .1 Diffusers.
 - .2 Registers.
 - .3 Grilles.
 - .4 Mounting frames.
 - .5 Finishes.
 - .6 Volume control damper adjustment keys.

2. Products

2.01 GENERAL

- .1 Types and Descriptions: In accordance with drawings or schedules.
- .2 Standards: In accordance with CAN/ULC-S102, CAN/ULC-S112 and ANSI/SMACNA 006.
- .3 Select type meeting noted capacity, throw and terminal velocity, noise criteria, pressure drop, and neck velocity.
- .4 Include mounting and connection accessories, suiting mounting locations and intended applications.
- .5 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames location as scheduled.
 - .3 Concealed fasteners.
- .6 Concealed manual volume control damper operators.
- .7 Select grilles, registers and diffusers of same generic type, as products of one manufacturer unless otherwise noted.

2.02 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Diffusers, Registers, and Grilles:
 - .1 Price Industries.
 - .2 Anemostat.
 - .3 Krueger (Air System Components).
 - .4 Titus.
 - .5 Nailor Industries.
 - .6 Tuttle & Bailey.

3. Execution

3.01 INSTALLATION DIFFUSERS, REGISTERS AND GRILLES

- .1 Refer to drawings or schedules for additional requirements.
- .2 Prior to ordering, review grille, registers and diffuser finishes, and colours with Consultant.
- .3 Install and connect grilles and diffusers in accordance with ANSI/SMACNA 006.
- .4 Locate grilles, registers and diffusers conforming to final reflected ceiling plans and detailed wall elevations, and coordinated with final luminaire arrangement, ceiling layout, ornamental and other wall treatment.
- .5 Equip supply diffusers having basic four-way or all-round air pattern for operation in one, two, or three-way patterns.
- .6 Equip ceiling-mounted diffusers and grilles with minimum two seismic type tabs.

- .7 Air handling luminaires with troffer type diffusers with boots:
 - .1 Prior to luminaire installation in ceilings, attach troffer type diffusers associated with typical ceiling mounted luminaires to luminaires on floor.
 - .2 When luminaires are installed, connect diffuser boots with flexible ductwork.
- .8 Sheet metal plenums constructed of same material as connecting duct: Where individual sections of linear grilles or diffusers are not equipped with volume control device, equip duct connection collars with volume control devices.
- .9 Linear type diffusers/grilles installed in suspended T-bar ceilings: Clip diffusers/grilles in place using clip supplied by diffuser/grille manufacturer.
- .10 Install grilles and diffusers located in gymnasiums or other similar rooms or spaces, with safety chains or other equal means.
- .11 Install door grilles in accordance with manufacturer instructions, suiting type of doors and intended applications.

3.02 PROTECTION

- .1 Provide protection for aluminum against galvanic action wherever dissimilar materials are in contact:
 - .1 By painting contact surfaces of dissimilar material with heavy coat of bituminous coating (complete coverage).
 - .2 By separating contact surfaces with performed synthetic rubber tape having pressure-sensitive adhesive coating on one side.
- .2 Isolate aluminum from plaster, concrete and masonry by coating aluminum with zinc chromate primer.

3.03 FIELD QUALITY CONTROL

- .1 Testing and Verification Work:
 - .1 When installation is complete, review and inspect installation, test and verify operations.
 - .2 Test and performance certify products in accordance with ANSI/ASHRAE Standard 70.
- .2 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 Air Movement and Control Association (AMCA):
 - .1 ANSI/AMCA Standard 500-L-[12(REV. 2015)], Laboratory Methods of Testing Louvers for Rating.
 - .2 AMCA Publication 511-[21], Certified Ratings Program - Product Rating Manual for Air Control Devices.
- .2 American Architectural Manufacturing Association (AAMA):
 - .1 AAMA 611-[20], Voluntary Specification for Anodized Architectural Aluminum.
 - .2 AAMA 2603-[22], Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
 - .3
- .3 ASTM International (ASTM):
 - .1 ASTM E90-[09(2016)], Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .2 ASTM E413-[22], Classification for Rating Sound Insulation.
- .4 Fenestration and Glazing Industry Alliance (FGIA):
 - .1 FGIA/AAMA 2605-[22], Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - .1 SMACNA Architectural Sheet Metal Manual, [7th Edition, 2012].
- .6 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-[Edition 8, 2018-REV1], Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Indicate:
 - .1 Types, finishes, shapes and sizes.
 - .2 Performance ratings not limited to:
 - .1 Pressure drops.
 - .2 Face areas.

- .3 Percentage free areas.
 - .4 Maximum throat velocity.
 - .5 Maximum static pressure loss.
 - .6 Maximum velocity through damper.
- .3 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.
- .3 Submit manufacturer colour chart from which finish colour is selected.
- .4 Submit samples of each type of following:
 - .1 Louvres.
 - .2 Vents.
 - .3 Intakes.
 - .4 Mounting frames
 - .5 Finishes.
 - .6 [].
- .5 Submit testing and verification reports.

2. Products

2.01 GENERAL

- .1 Refer to requirements with Section 08 90 00 - Louvres and Vents and Section 08 91 16 - Operable Louvres.
- .2 Provide products as scheduled.
- .3 Louvre Performance: In accordance with ANSI/AMCA Standard 500-L.
- .4 Include mounting and connection accessories suiting intended mounting location and intended application.
- .5 Drainable where noted.
- .6 Finishes:
 - .1 Steel:
 - .1 Factory finished with 70% fluoropolymer powder extrusion coatings.
 - .2 Two-coat systems consisting of patented primer and durable colour coat.
 - .3 In accordance with FGIA/AAMA 2605.
 - .4 Final clear coat over cleaned and primed metal with colour as selected from manufacturer standard colour range.
 - .2 Aluminum:
 - .1 In accordance with AAMA 611 and AAMA 2603.
 - .3 Final finish and colour reviewed with Consultant for recommendations of acceptance during shop drawing submissions.

2.02 FIXED LOUVRES - ALUMINUM

- .1 Construction:
 - .1 Welded with exposed joints ground flush and smooth.
 - .2 Designed to withstand 122 kg/m² wind load, unless otherwise noted.

- .2 Material: Extruded aluminum alloy 6063-T5.
- .3 Blades:
 - .1 Fixed.
 - .2 Stormproof pattern with centre watershed in blade, and reinforcing bosses.
 - .3 Minimum 2 mm thick, 100 mm wide.
 - .4 Positioned at 39° angles.
- .4 Frames, Heads, Sills and Jambs:
 - .1 [100] or [150] mm deep one-piece extruded aluminum, minimum 2 mm thick.
 - .2 With caulking slot, integral to unit.
- .5 Mullions: At 1500 mm maximum centres.
- .6 Fastenings:
 - .1 Stainless steel SAE-194-8F with SAE-194-SFB nuts.
 - .2 Resilient neoprene washers between aluminum and head of bolt, stainless steel washers and aluminum body.
- .7 Screens: Integral aluminum wire mesh permanently secured to formed aluminum frame and mounted on interior louver face.
- .8 Drainable where noted.

2.03 WIRE MESH SCREENS

- .1 Heavy-gauge, corrosion resistant, minimum 2.7 mm diameter stainless steel wire, secured in rigid galvanized steel or aluminum framework, and removable.
- .2 Unless otherwise noted, 12 mm square mesh on exhaust and 19 mm square mesh on intake.
- .3 Fasten frames to louvers with devices of same material finish as louvers designed allowing removal and replacement without damage to screen or louver.

2.04 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Louvres:
 - .1 Price Industries:
 - .1 Fixed: DE439 or DE635.
 - .2 Airolite.
 - .3 Construction Specialties.
 - .4 Nailor Industries.
 - .5 Greenheck.
 - .6 Pottorff.
- .2 Acoustic Louvres:
 - .1 Greenheck.,
 - .2 Twin City Fan and Blower.
 - .3 PennBarry.
 - .4 Pottorff.

3. Execution

3.01 INSTALLATION OF LOUVRES

- .1 Install in accordance with manufacturer instructions and SMACNA Architectural Sheet Metal Manual recommendations.
- .2 Verify dimensions at site.
- .3 Set units level, plumb and true to line, with uniform joints.
- .4 Reinforce and brace.
- .5 Anchor securely into opening. Seal with caulking weather-tight.
- .6 Prior to fabrication, review finishes with Consultant.

3.02 INSTALLATION OF WIRE MESH SCREENS

- .1 As reviewed with Consultant, provide framed, removable wire mesh screens over openings:
 - .1 In ducts.
 - .2 In walls.
 - .3 Other applications as noted.
- .2 Rigidly secure in place but allowing screens to be removable.
- .3 Provide wire mesh screens for open-end return air ducts in ceiling spaces.

3.03 PROTECTION

- .1 Provide protection for aluminum against galvanic action wherever dissimilar materials are in contact:
 - .1 By painting contact surfaces of dissimilar material with heavy coat of bituminous coating (complete coverage).
 - .2 By separating contact surfaces with performed synthetic rubber tape having pressure sensitive adhesive coating on one side.
- .2 Isolate aluminum from plaster, concrete and masonry by coating aluminum with zinc chromate primer.

3.04 FIELD QUALITY CONTROL

- .1 When installation is complete, review and inspect installation, test and verify performance and adjustable operations where applicable.
- .2 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standard Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ANSI/ASHRAE):
 - .1 ANSI/ASHRAE Standard 52.2-[2017], Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size.
- .2 Institute of Environmental Sciences and Technology (IEST):
 - .1 IEST RP-CC001-[2016], HEPA and ULPA Filters.
- .3 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S111-[Edition 5,13-R2018], Standard Method of Fire Tests for Air Filter Units.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include following:
 - .1 Dimension size.
 - .2 Maximum pressure drop when dirty.
 - .3 Maximum pressure drop when clean.
 - .4 Efficiency rating for AHU.
 - .5 ULC certification.
 - .6 Proof of capability of withstanding rating without failure.
- .3 Submit samples of each type of filter.
- .4 Submit list identifying filters required for each equipment.
- .5 Submit manufacturer compliance certificates certifying that materials comply with specified performance characteristics and physical properties.
- .6 Submit testing and verification reports.

1.03 SPARE PARTS

- .1 Supply following spare parts:
 - .1 Complete spare set of filter media in original packaging and clearly identified as to applicable system for each air handling system with filters.
- .2 Store filters at site where directed by Owner and reviewed with Consultant.

2. Products

2.01 GENERAL

- .1 Provide filters as scheduled or noted.
- .2 Minimum Efficiency Reporting Values (MERV) Ratings: In accordance with ANSI/ASHRAE Standard 52.2.
- .3 Filters: ULC Class 1 certified in accordance with CAN/ULC-S111.
- .4 Media to maintain or increase in efficiency over life of filter.
- .5 Submit product samples with shop drawing submissions. Review requirements with Consultant.

2.02 CONSTRUCTION FILTERS

- .1 Roll or pleated disposable type.
- .2 MERV 13 unless otherwise noted.
- .3 Woven glass fibre media, ULC Class 2.

2.03 PRE-FILTERS - PLEATED PANEL TYPE

- .1 In accordance with ANSI/ASHRAE Standard 52.2 for minimum efficiency reporting value of MERV 9 or MERV-A of 9 as noted, when tested in accordance with Appendix J of standard.
- .2 Pleated panels consisting of layers of lofted polyester media, welded wire media support grid, and beverage board enclosing frame with no less than 28-points high wet-strength.
- .3 Frame bonded to media on frame sides preventing air bypass.
- .4 Integral diagonal support members on air entering and air exiting side bonded to apex of each pleat, maintains uniform pleat configuration in varying airflows.
- .5 Welded wire grid treated for corrosion resistance and bonded to downstream side of media. Maintains radial pleats and prevents media oscillation.

2.04 FINAL FILTERS - CARTRIDGE TYPE

- .1 In accordance with ANSI/ASHRAE Standard 52.2, for minimum efficiency reporting value of MERV 11, 13, 14, and 16 or MERV-A 11, 13, 14, and 16, as noted, when tested in accordance with Appendix J of standard.
- .2 V-bank mini-pleated fiberglass disposable type with pleat separators, polyurethane pack-to-frame sealant, and polystyrene enclosing frame with top and bottom moulded tracks providing proper seal.
- .3 Microfine glass fibers formed into uniform pleats, providing even airflow through filter pack.

2.05 FILTER FRAMING AND RACKS

- .1 No. 16 gauge galvanized steel filter framing and racks.
- .2 Sized and arranged suiting filters and filter bank, and easily accessible for filter service and replacement.
- .3 Slide-in tracks or lay-in flanges as required for filter placement, and gasketing and facilities preventing air by-pass.

2.06 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Filters:
 - .1 American Air Filter (AAF).
 - .2 Camfil.
 - .3 Modern Air Filters.
- .2 Filter Gauges:
 - .1 Inclined Manometer Type: Equal to Dwyer Instruments, Model 250.5-AF.
 - .2 Dial Type: Equal to Dwyer Instruments, Series 2000 Magnehelic.

3. Execution

3.01 INSTALLATION OF FILTERS

- .1 Install filters in accordance with manufacturer recommendations and with space for access, maintenance and replacement. Coordinate with equipment requirements.
- .2 Provide filter media when fan equipment is ready for start-up and performance testing. Provide filter framing and racks.
- .3 Before acceptance, perform tests demonstrating integrity of complete installation.
- .4 Construction Filters:
 - .1 Install roll or pleated type medium efficiency disposable filters across entire filter bank of each supply air handling unit, either at factory where fan is produced or at site as soon as fan installed. Secure filter media in place preventing dislodgement by fan operation. Replace filter media periodically when it becomes loaded and clogged.
 - .2 Exhaust Systems: Secure filter media across exhaust air openings and ductwork preventing construction dirt and dust from fouling fan.
 - .3 Leave filter media in place until fan start-up, at which time remove and dispose of construction media.

3.02 FIELD QUALITY CONTROL

- .1 Check that filter media is new and clean, as indicated by pressure gauge, at time of acceptance.
- .2 When installation is complete, review and inspect installation, test and verify operations. Perform following:
 - .1 Check pressure drops across filters in accordance with manufacturer guidelines.
 - .2 During TAB, install substitute media having similar pressure drop.
 - .3 Gauges: Inspect and test performance.
- .3 Prepare testing and verification reports, signed by testing technician. Submit copies to Consultant.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data for all units. Include:
 - .1 certified fan performance curves;
 - .2 estimated sound power levels to be expected across individual octave bands in dB;
 - .3 certified power and control wiring diagrams which differentiate between factory and site wiring;
 - .4 dimensioned layouts, including dimensioned curb layouts and duct penetrations, as applicable;
 - .5 product data for fan motors and drives;
 - .6 all items shipped loose for site installation.
- .2 Submit with delivery of each unit a copy of the factory inspection and fire test 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 spare air filters as specified in Part 2 of this Section.
- .5 Supply reviewed copies of curb assembly shop drawings or product data sheets to trade who will cut roof openings for ductwork, and ensure openings are properly sized and located.
- .6 Submit signed copies of manufacturer's extended warranties as follows:
 - .1 stainless steel gas fired unit heat exchanger: 10 years;
 - .2 refrigerant compressor(s): 5 years;
 - .3 integrated modular control: 3 years.

1.02 QUALITY ASSURANCE

- .1 Heating and air conditioning equipment is to be rated (capacity, performance, efficiency and sound) and certified in accordance with requirements of following Air-Conditioning, Heating and Refrigeration Institute Standards:
 - .1 ANSI/AHRI 210/240, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment;
 - .2 ANSI/AHRI 270, Sound Performance Rating of Outdoor Unitary Equipment;
 - .3 ANSI/AHRI 340/360, Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.

- .2 Heating and air conditioning equipment is also to be in accordance with requirements of following Codes, Standards, and Regulations:
 - .1 CSA B52, Mechanical Refrigeration Code;
 - .2 CAN/CSA-C22.2 No. 236/UL 1995, Heating and Cooling Units;
 - .3 ANSI/ASHRAE/IES 90.1, Energy Standard for Buildings Except Low Rise Residential Buildings;
 - .4 CSA or ETL certification and labelling for all electrical components;
 - .5 governing local Codes and Regulations.
- .3 Acceptable manufacturers are:
 - .1 Lennox Industries Inc.;
 - .2 Carrier Corp.;
 - .3 Trane Canada Corp.;
 - .4 Johnson Controls York.

2 PRODUCTS

2.01 OUTDOOR AIR CONDITIONING UNITS

- .1 Package type, factory tested, outdoor, weatherproof heating and air conditioning units in accordance with drawing schedule.
- .2 Cabinet constructed of minimum #18 gauge galvanized steel panels erected on full perimeter minimum #14 gauge galvanized steel base rails with lifting lugs, finished with 2 coats of baked exterior enamel paint on primer, arranged and constructed for airflow configurations as shown, and complete with collars for electrical power and duct connection openings, and following:
 - .1 fully insulated base, and insulation for all panels adjacent to conditioned air, with 50 mm (2") thick neoprene faced, 32 kg/m³ (2 lb/ft³) density insulation meeting 25/50 flame spread/smoke developed ratings when tested to CAN/ULC S102 and secured in place such that insulation will not sag and fibres will not erode or enter airstream;
 - .2 hinged access panels, each air and water sealed and equipped with ¼ turn latching handles, and provided for compressor/controls/heating areas, blower access, and air filter and economizer access.
- .3 Vibration isolated scroll type hermetically sealed compressor(s) with direct drive vertical discharge propeller type condenser fan(s) and copper tube/aluminium fin factory leak and pressure tested condenser coil(s), and equipped with following:
 - .1 PVC coated condenser fan guard and condenser coil guard;
 - .2 permanently lubricated totally enclosed, resiliently mounted, overload protected condenser fan motor(s) conforming to requirements of Section entitled Basic Mechanical Materials and Methods, totally enclosed from the weather;

- .3 refrigeration system capable of operating down to -18°C without installation of additional controls, complete with self-sealing discharge, suction and liquid line service gauge ports, freeze-stats, expansion valves, copper refrigerant tubing and insulation where required, liquid line filter drier, a full charge of R454B refrigerant, automatic reset high and low pressure compressor circuit controls, and fan control for -34°C (-30°F) low ambient operation;
 - .4 copper tube/aluminium fin factory tested evaporator coil with thermal expansion valve with adjustable superheat and external equalizer, and non-corrosive condensate drain pan removable for cleaning, designed to prevent standing water and equipped with a drain connection with deep seal trap.
- .4 Cooling controls include following:
- .1 smoke detectors in both supply and return air streams;
 - .2 motorized normally closed fresh air and exhaust air dampers and normally open return air damper (equal to T. A. Morrison Tamco Series 1000 for return air and Series 9000 for fresh air and exhaust air), with 24 volt spring return Belimo or equal operators and a control package to automatically vary the outside air quantity;
 - .3 adjustable mixed air controls to maintain 13°C, or as indicated, mixed air temperature;
 - .4 units shall have 1 stage of cooling. 3-5TR high efficiency units shall have 2 stages of cooling. All 6-17.5 TR unit shall have 3 stages of cooling. All 20-25TR units shall have 4 stages of cooling. controls for blower on delay of up to 60 seconds after a cooling demand has been received, with a default value of zero, and controls to allow blower off delay of up to 240 seconds after cooling demand has ended, with a default value of zero;
 - .5 minimum compressor on and off time of 300 seconds, both adjustable between 60 and 510 seconds;
 - .6 default maximum high pressure switch trip occurrence during cooling or dehumidification cycle of 3 (adjustable between 1 and 8 occurrences), with compressor lock-out if maximum occurrence limit is reached, and digital output for service activated;
 - .7 low pressure trip read delay of 5 minutes (adjustable between 0 and 34 minutes) if compressor off time has been less than 4 hours (adjustable between 1 and 6 hours) and outdoor temperature is less than 21°C, adjustable between -12°C and 38°C;
 - .8 low pressure trip read delay of 15 minutes (adjustable between 0 and 34 minutes) if compressor off time has been less than 4 hours (adjustable between 1 and 6 hours) and outdoor temperature is less than 21°C (70°F), adjustable between -12°C and 38°C;
 - .9 low pressure trip read delay of 2 minutes (adjustable between 0 and 34 minutes) if the compressor off time has been less than 4 hours and outdoor air temperature is 21°C or greater;
 - .10 low pressure trip read delay of 8 minutes (adjustable between 0 and 34 minutes) if the compressor off time has been 4 hours and outdoor air temperature is 21°C or greater;

- .11 each pressure switch trip occurrence (either high or low) to record an error in non-volatile memory and identify compressor circuit;
- .12 low outdoor air temperature compressor lockout set-point of -18°C for each compressor circuit, individually adjustable from 27°C to -34°C
- .13 maximum allowable evaporator freeze-stat trip occurrence of 3 (adjustable between 1 and 4 occurrences) during cooling demand, with circuitry to shut-off compressor each time a freeze-stat trip occurs and record an error in non-volatile memory, and if maximum limit is reached, compressor is to be locked-out and a digital output for service is to be displayed;
- .14 condenser fan control including:
 - .1 6 second (adjustable between 0 and 16 seconds) between condenser fan shut-off and restart to prevent reverse rotation of fan(s);
 - .2 cooling stage low outdoor temperature set-point control (4°C to 13°C) depending on number of fans and adjustable between -12°C and 16°C to reduce airflow through condenser by turning off some or all fans, depending on number of condenser fans.
- .5 Roll type glass fibre mesh construction filter media factory installed when unit is shipped, and disposable, 50 mm (2") thick, pleated, UL Class 1 MERV 13 rated, metal framed filters with an initial loading of filters, and a spare set of filters for each unit, supplied loose in sealed containers.
- .6 CSA certified, removable and completely accessible Nichrome bare wire element heating coil, complete with factory pre-wired power and control panel equipped with modulating SCR controller, indicating light centre, fuse blocks with fuses, integral fused control transformer, thermal cut-outs in accordance with CSA requirements, door interlock unfused disconnect switch, high limit temperature control connected to de-energize elements to protect against overheating and following controls:
 - .1 supply fan start before electric elements are energized, and continue to operate until bonnet temperature reaches minimum setting;
 - .2 switch to permit continuous fan operation;
 - .3 control to turn off supply fan 20 seconds after heating demand has ended (adjustable between 0 and 300 seconds);
 - .4 controls to turn off heating coil and keep supply fan running if an overheat limit occurs;
 - .5 maximum overheat limit trip count of 3 (adjustable between 1 and 15) during heating cycle, with digital output, limit indicator;
 - .6 overheat limit trip error identification and reporting, with error code stored in non-volatile memory.
- .7 Centrifugal, statically and dynamically balanced, removable (slide-out) blower assembly complete with:

- .1 motor conforming to requirements specified in Section entitled Basic Mechanical Materials and Methods, and a variable frequency drive conforming to requirements specified in Section entitled Variable Frequency Drives.
- .8 Integral solid-state control board to operate unit, compatible in all respects with building automation system, and with built-in functions as follows:
 - .1 blower on/off delay;
 - .2 control parameter defaults;
 - .3 service relay output;
 - .4 dirty filter switch input;
 - .5 dehumidistat input;
 - .6 economizer control;
 - .7 unit diagnostics;
 - .8 diagnostics code storage;
 - .9 indoor air quality input;
 - .10 low ambient controls;
 - .11 minimum run time;
 - .12 night setback mode;
 - .13 smoke alarm mode;
 - .14 low pressure control;
 - .15 thermostat bounce relay;
 - .16 3-digit display and °F or °C display;
 - .17 heat/cool thermostat compatible with warm-up mode.
- .9 Minimum 450 mm (18") high prefabricated and insulated curb conforming to requirements of National Roofing Contractors Association. Curb shall be heavy gauge zinc coated steel with nominal two-inch by four-inch nailer setup. Supply/return air opening gasketing shall be provided. Curb shall ship knocked down for easy assembly. Channel shall be provided to allow for adjustment of return air opening location.
- .10 Economizer shall be available with barometric relief. It shall be fully modulating from 0 to 100 percent and shall include provision for a minimum position setting. Assembly also includes, preset linkage, wiring harness with plug, and spring return actuator. A standard discharge air sensor shall be included on all units with economizers.

- .11 Unit shall be furnished with a leak detection system from the factory when a circuit refrigerant charge exceeds 3.91 lbs. The leak detection system shall consist of one or more refrigerant detection sensors. When the system detects a leak, the unit controller shall initiate mitigation actions.
- .12 Through-the-Base Electrical connection with Circuit Breaker. Circuit breaker installed within unit in water tight enclosure sized per NEC and cULus guidelines, and agency recognized by cULus.

3 EXECUTION

3.01 INSTALLATION OF HEATING AND AIR CONDITIONING UNITS

- .1 Provide outdoor heating and air conditioning units.
- .2 Provide required rigging and hoisting/moving equipment required to move each unit to required locations. Perform rigging/hoisting/moving in accordance with unit manufacturer's directions and details.
- .3 Hand a curb for each roof mounted unit to roofing trade on roof for installation and flashing into roof construction. Secure each unit in place on roof curb. Provide continuous gasketing around perimeter of each curb between curb and unit mounting frame.
- .4 Secure base mounting units in place, level, and plumb, on a fabricated steel base or concrete pad.
- .5 .
- .6 Install components shipped loose with units. Install in accordance with manufacturer's recommendations. Calibrate control components requiring field calibration.
- .7 Extend condensate trapped drains using Schedule 40 galvanized steel piping to roof.
- .8 Provide thermostats and wall mount on a recessed box. Confirm exact locations prior to roughing-in. Connect complete with 24 volt control wiring in conduit to standards of electrical work and manufacturer's certified wiring diagram. Set-up and program thermostats in accordance with Owner's requirements.
- .9 Carefully coordinate installation of each unit with all other trades making connections to unit, in particular, power, interlock connections, and control connections.
- .10 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .11 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .12 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

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets, complete with control components, and piping and wiring schematics.
- .2 Submit a start-up and certification letter from equipment supplier as specified in Part 3 of this Section.
- .3 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.

1.02 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.

2. Products

2.01 SPLIT SYSTEM AIR CONDITIONING EQUIPMENT

- .1 Factory assembled and tested, package type equipment consisting of an indoor evaporator unit and an exterior condensing unit in accordance with drawing schedule, CSA or ETL listed and labelled, AHRI rated and certified and with a minimum system efficiency of 13 SEER.
- .2 Wall mounting evaporator assembly consisting of a white moulded high-strength plastic cabinet with front access panel, a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction and which closes when fan operation is stopped, motorized vertical vanes controlled remotely, and a mounting plate supplied loose. Evaporator complete with:
 - .1 double inlet, forward curve fan(s) direct driven by a single 4-speed motor;
 - .2 removable and washable return air filter;
 - .3 factory pressure tested multi-angled coil of non-ferrous construction with aluminium fins, copper tubes with silver alloy solder joints, and an insulated condensate drain pan sloped to a drain connection for positive drainage.

- .3 Factory run tested, weatherproof condensing unit equipped with a control board to interface with indoor unit and perform all necessary operation functions. Pre-charge unit with R-410a refrigerant for a minimum of 21 m (70') of refrigerant tubing. Unit is to be capable of operation at -18°C (0°F) without additional low ambient controls, and capable of a height difference between condensing unit and evaporator of 30 m (100'). Each condensing unit complete with:
 - .1 galvanized steel plate cabinet with an electrostatically applied thermally fused polyester powder finish, and an ABS plastic fan grille;
 - .2 draw-through direct driven balanced fan with horizontal air discharge, mounted in front of coil, arranged to pull air across coil, and equipped with a raised fan guard;
 - .3 "L" shaped coil with copper tubes and aluminium fins, factory pressure tested, complete with an integral metal guard and refrigerant flow controlled by a linear expansion valve metering orifice controlled by a microprocessor controlled step motor;
 - .4 vibration isolated DC rotary compressor driven by an inverter circuit to dynamically control compressor speed to match room load, complete with an accumulator, high pressure safety switch, and circuitry to permit a minimal amount of current to be applied to motor to maintain enough heat during off cycle to prevent liquid from accumulating.
- .4 System controls consisting of a microprocessor in each indoor and outdoor unit, and an indoor wall mounted controller site connected to indoor evaporator unit. System is to be capable of automatic restart after power interruption, and have self-diagnostics ability and indication of total compressor run time, and following:
 - .1 Indoor unit microprocessor is capable of monitoring return air temperature and evaporator coil temperature, receiving and processing commands from wall mounted controller, providing emergency operation, and controlling outdoor unit through its microprocessor and interface board;
 - .2 controller is complete with an integral temperature sensor, able to perform input and output functions necessary to operate system, and equipped with following:
 - .1 large DOT liquid crystal display to indicate diagnostic codes for both indoor and outdoor units, compressor run time, a weekly timer with up to 8 pattern settings per day, set temperature, room temperature, refrigerant piping temperatures, compressor operating conditions, and linear expansion valve opening pulses, sub-cooling and discharge super heat;
 - .2 On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louvre Swing button, a Ventilation button, a Test Run button, and a Check Mode button.
 - .3 Coordinate with the unit manufacturer to provide local controller with BACnet communication compatibility.
- .5 Suitable anchoring connection hardware factory installed on equipment to suit requirements of Section entitled Seismic Control and Restraint.
- .6 Acceptable manufacturers are:

- .1 Mitsubishi Electric Sales Canada Inc.;
- .2 LG Electronics Canada Inc.;
- .3 Panasonic Canada Inc.;
- .4 Fujitsu General America Inc.

3. EXECUTION

3.01 INSTALLATION OF SPLIT SYSTEM AIR CONDITIONING EQUIPMENT

- .1 Provide split system air conditioning equipment consisting of an exterior condensing unit and an indoor evaporator.
- .2 Secure condensing unit in place, level and plumb, ECOFOOT mini strut mounting system complete with vibration isolation pads and concrete housekeeping pad.
- .3 Anchor equipment in accordance with requirements specified in Section entitled Seismic Control and Restraint. Provide flexible connections in all piping connections to equipment.
- .4 Mount indoor evaporator unit. Confirm exact location prior to roughing-in.
- .5 Connect condensing unit and indoor evaporator with refrigerant piping in accordance with piping shop drawing schematic. Refer to Section entitled Refrigerant Piping, Valves, and Accessories. Provide any required additional refrigerant.
- .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 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .8 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .9 Include for 4 hours of on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, with control set-up and abnormal events.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 ASTM International (ASTM):
 - .1 ASTM C1071-[19], Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .2 ASTM E84-[21a], Standard Test Method for Surface Burning Characteristics of Building Materials.
- .2 CSA Group (CSA):
 - .1 CSA B214-[21], Installation Code for Hydronic Heating Systems.
- .3 National Fire Protection Agency (NFPA):
 - .1 NFPA 90A-[2024], Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-[2024], Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .4 Underwriter Laboratories (UL):
 - .1 ANSI/UL 2021-[2021], Standard for Fixed and Location-Dedicated Electric Room Heaters.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Indicate:
 - .1 Equipment, capacity and piping connections.
 - .2 Dimensions, internal and external construction details, recommended method of installation with proposed support, sizes and location of mounting bolt holes.
- .3 Submit manufacturer standard colour charts.
- .4 Submit testing and verification reports.

2. Products

2.01 GENERAL

- .1 Unit Heaters: CSA certified and in accordance with ANSI/UL 2021.
- .2 Refer to schedules for additional requirements such as hot water or electric heating, ducting, recessed or semi-recessed or surface mounting, ratings and type of controls.

- .3 Forced air cabinet heaters, unit heater and fan-coil capacities are based on [18.3]°C entering air temperature.

2.02 HORIZONTAL UNIT HEATERS

- .1 Casing:
 - .1 Minimum 18 gauge cold rolled steel treated, preventing corrosion.
 - .2 Prior to application of electrostatically applied powder coat paint finish, degreased and chemically phosphatized.
 - .3 Threaded connections for hanger rods, for suspension of units.
- .2 Coils: Types as scheduled:
 - .1 Electric Coils:
 - .1 Nickel-chrome resistance coils embedded in refractory material and enclosed in steel sheathing with high watt density extended fins.
 - .2 Two stage heating with magnetic contactors, high temperature limit switch, and fan override switch.
- .3 Fan:
 - .1 Direct drive propeller type.
 - .2 Factory dynamically balanced.
 - .3 Aluminum blades, steel hub with anti-corrosive finish.
 - .4 Fan protective guard.
- .4 Motor:
 - .1 Speed as noted.
 - .2 Continuous duty TEFC motor.
 - .3 Built-in overload protection.
 - .4 Resilient motor explosion proof supports.
- .5 Air Outlet: Four-way adjustable, 18 gauge steel louvres.
- .6 Controls:
 - .1 Contacts and interfaces of type for connection to BMS/BAS. Coordinate with requirements of Division 25.

2.03 BASEBOARD HEATERS

- .1 Low profile wall mount baseboard heaters, each approximately 150 mm (6") high, 65 mm (2-1/2") deep, complete with:
 - .1 #22 gauge steel body with #20 gauge steel connection box at both ends of heater, 2 rows of mounting holes, single screw built-in wire holder, and #20 gauge steel removable front panel with rounded upper corners;
 - .2 standard watt density (900 W/m) tubular steel heating element with aluminium fins, noise free and floating on high temperature nylon bushings;
 - .3 factory installed, tamperproof, adjustable bi-metal thermostat;
 - .4 factory supplied enclosure accessories as indicated on drawings and/or heater schedule;
 - .5 factory supplied control components in accordance with drawing schedule, with low voltage/line voltage barrier as required.

2.04 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Unit Heaters:
 - .1 Modine Manufacturing.
 - .2 Rosemex.
 - .3 Armstrong-Hunt.
 - .4 Chromolox
- .2 Baseboard Heaters:
 - .1 Ouellet Canada Inc.;
 - .2 Chromalox Inc.;
 - .3 Stelpro Design Inc.

3. Execution

3.01 INSTALLATION

- .1 Install in accordance with manufacturer instructions, and referenced codes including CSA B214, NFPA 90A and NFPA 90B.
- .2 Prior to roughing-in, review final locations of products with Consultant. Where deviations beyond allowable clearances arise, advise Consultant and obtain directives.
- .3 Coordinate installation of cabinet unit heaters with trades constructing building surfaces in or on which heaters are located.
- .4 Clean finned tubes and comb straight.
- .5 Secure unit heaters in place, by means of hanger rods attached to structure. Review height with Consultant. Provide supplementary suspension steel suiting intended installation locations.
- .6 Where required, brace and secure each unit in accordance with vibration and seismic control and restraint requirements.
- .7 Provide power connection to units. Coordinate electrical connections with work of Division 26.
- .8 Before acceptance, set discharge patterns and fan speeds, suiting requirements of design and intended applications.
- .9 During shop drawing submissions, review type of controls as with Consultant. Install controls in locations.
- .10 During shop drawing submissions, review cabinet exterior finishes with Consultant.

3.02 IDENTIFICATION

- .1 Provide identification nameplate on equipment enclosures identifying equipment and performance ratings.
- .2 Main Nameplates: Size No. 4 unless otherwise noted, and engraved as noted.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Start-Up, Testing and Verification:

- .1 In accordance with manufacturer recommendations.
 - .2 When installation is complete and piping has been permanently filled, start-up each unit, check and test operating controls.
 - .3 Perform tests as recommended by manufacturer and Consultant, verifying units are functional.
- .2 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1 GENERAL

1.01 DESCRIPTION OF WORK

- .1 Provide labour, materials, equipment and services necessary for a complete Building Automation System (BAS) comprised of various types of BACnet Testing Laboratories (BTL) listed BACnet-communicating Direct Digital Control (DDC) controllers (referred to as "BAS Controllers"), BTL listed BACnet-communicating operator interface software, conventional electric/electronic controls, and equipment-mounted controls. System is to be fully functional and include software and hardware for specified capabilities.
- .2 Refer to Section entitled Automatic Control Systems for requirements regarding control valves, control dampers, actuators, sensors/transmitters, switches/auxiliary control devices, and other similar field devices.
- .3 Summary of Project Scope:
 - .1 Refer to drawings

Integrate and coordinate controls required by this project into a single system as follows:
 - .2 Each supplier of a controls product is responsible for installation, configuration, programming, start-up and testing of that product unless otherwise stated.
 - .3 Coordinate resolution of any incompatibility issues between BAS products provided under this section and those provided elsewhere in Contract Documents. Equipment/system manufacturer/supplier is responsible for supplying technicians that are to be available to troubleshoot any issues and coordinate with contractor.
 - .4 Be responsible for material and labour to interconnect control products provided by multiple suppliers regardless of where these products are described within Contract Documents.
 - .5 Coordinate to ensure sufficient space and power for BAS components is provided/available.
 - .6 Resolve any conflicts that arise in control of same equipment by both BAS and fire alarm systems. Coordinate with fire alarm system manufacturer and installing contractor to resolve any issues that arise. Fire alarm system control is to be given priority, except where stated otherwise.

1.02 DEFINITIONS/ABBREVIATIONS

- .1 Advanced Application Controller (AAC) – Fully programmable controller which is BTL-listed as a B-AAC device and which communicates via BACnet MS/TP to an associated network controller (NC). These controllers are used for terminal unit (including VAV boxes) and small AHU/RTU control.
- .2 Application Specific Controller (ASC) – Low-level MS/TP controller typically not custom-programmable and BTL-listed as a B-ASC device.
- .3 BACnet/IP – Use of Ethernet and IP data/network link protocols to transport BACnet messages.

- .4 B-BC, B-AAC, B-ASC and B-AWS – Abbreviations for BACnet Building Controller, BACnet Advanced Application Controller, BACnet Application Specific Controller, and BACnet Advanced Operator Workstation Software. Used by BACnet standard and BTL to define various device and software profiles, and BACnet functionality to be provided by different classes of DDC devices (for support of interoperability).
- .5 BBMD – BACnet/IP Broadcast Management Device. Method used by BACnet for handling broadcast messages over IP (which does not support broadcasting). Approach involves use of one BACnet/IP device per IP segment to maintain a Broadcast Distribution Table (BDT) listing all other BACnet devices on that network segment. This allows a multi-cast message sent over IP (to each BBMD) to be in turn broadcasted to all other devices on each BACnet/IP segment.
- .6 BTL – BACnet Testing Laboratory. Provides BACnet conformance testing (e.g., to confirm a B-BC device meets minimum requirements for Building Controller profile as defined in BACnet standard). If device passes BTL testing it is said to be "BTL-listed" as, say, a "B-BC device". Devices tested by an ISO accredited laboratory may also issue a certificate, and be referred to as "BTL-certified" device.
- .7 COV (Change of Value) – Optional BACnet service that allows data to be communicated only when it has changed state and/or has changed its value by a pre-defined threshold. This service substantially reduces use of communications bandwidth by BACnet in lieu of using standard "Read" services (which must be polled at regular intervals to ensure changes in values are seen by system).
- .8 FEC – field equipment controller; AAC's and ASC's are field equipment controllers.
- .9 Gateway – Software used to translate one application's protocol data (i.e., BACnet) to another (e.g., Modbus or LonTalk). This software can be installed as a "driver" in a BAS controller (i.e., for Modbus) or provided by a separate gateway device (i.e., for LonTalk) so BAS can connect to "Third Party" devices).
- .10 MS/TP – Master-Slave/Token-Passing, an EIA-485 data link technology unique to and defined by BACnet for transport of BACnet messages.
- .11 NC – Network Controller, highest-level controller in BAS architecture, with B-BC listing, BACnet/IP communications, and routing to/from MS/TP controller sub-networks.
- .12 PICS – Protocol Implementation Conformance Statement, a BACnet form that must be completed for BTL-listing in which device's BACnet device profile (e.g., B-BC), required feature choices (e.g., BACnet/IP vs. MS/TP), and optional features (e.g., COV) are to be documented.

1.03 SUBMITTALS

- .1 For each control device submit shop drawings/product data sheets including manufacturer's name, product name and specific model number, options included, product image, proof of BTL listing, dimensions, functional description and operating characteristics, protocol conformance information, and electrical requirements (AC vs. DC, voltage and current draw, or VA).
- .2 Provide system architecture diagram showing communications wiring topology, model number or designation of each communicating device, HVAC or other system/equipment controlled, location and designation of each enclosure containing communicating device, and connections to 3rd party controls.

- .3 Provide schematic diagram of each controlled system/equipment showing point devices/interfaces with a point naming scheme matching that used on associated control enclosure wiring diagram. Provide a bill of material for devices shown with nomenclature keyed to catalogue data.
- .4 Proprietary services and object types, if used in system, to be thoroughly documented and provided as part of submittal data. Necessary tools to be supplied for working with proprietary information.
- .5 Provide floor plans showing enclosure locations, field devices not mounted in enclosures or on equipment (e.g., space temperature), terminal devices (e.g., VAV box) controller locations, and workstation/server locations.
- .6 Provide enclosure layout and wiring diagram showing BAS controllers, gateways/interfaces to 3rd party controls, enclosure-mounted field devices, internal wiring and wiring to field devices (with wiring tags matching those used on schematic diagrams), a point list with expanded point description information, communications wiring connections, and power supply. Label enclosure devices and key to bill of materials.
- .7 Provide sequence of operation modified and expanded from that provided in this specification to include control details specific to mechanical and controls equipment provided.
- .8 Provide list of data communicated via digital communications interfaces to 3rd party controls (e.g., a chiller or boiler gateway).
 - .1 Prior to completion of submittals, coordinate with 3rd party equipment suppliers to review their documentation and verify data (i.e., BACnet objects and properties, Modbus registers, etc.) required to complete system is available.
 - .2 Prior to completion of submittals, schedule meeting with Consultant to review data lists available for communication to/from 3rd party controls. Based on Consultant's input modify list of data to be communicated from that specified.
- .9 Provide a list of graphic screens, and, for each screen, conceptual layout with points/data to be included and linkages to other screens. Meet with Owner and Consultant prior to submittals to determine their graphic screen format and content preferences.
- .10 Provide, for review, a description of BAS acceptance tests along with forms/checklists to be used during testing.
- .11 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

1.04 QUALITY ASSURANCE

- .1 Electrical installation work is to comply with latest version of local governing electrical code and installed by experienced personnel trained by BAS manufacturer/supplier.
- .2 Provide electrical products which have been tested, listed and labelled by CSA or ULC, and comply with NEMA standards.
- .3 Comply with following codes and standards:
 - .1 UL 916, Energy Management Equipment;

- .2 ASHRAE BACnet Standard 135;
- .3 local governing electrical code.
- .4 Controls Contractor is to provide an experienced project manager (minimum 10 years of related experience) to oversee all aspects of project including design, installation and start-up.
- .5 Anyone involved in design, installation, programming and verification of BAS are to be authorized and trained by BAS manufacturer.

1.05 WARRANTY

- .1 Provide labour, material and equipment necessary for operation of BAS according to design for a period of 1 year after Substantial Completion of Project. Warranty or final completion service is to be scheduled with Owner to minimize disruptions to facility operations.
- .2 Provide Owner with a telephone number where service representative can be reached at all times. Within 24 hours after receiving a request for service, problem is to be remotely resolved (i.e. via remote communications with BAS) or service personnel are to be at site. Fully restore BAS to proper operating condition within 2 days.

1.06 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers are:
 - .1 Johnson Controls Inc.;
 - .2 Siemens Building Technologies;
- .2 BAS controllers and operator interface software are to be by one of above manufacturers, except when controls are specified under another section (i.e., referenced as "controls provided with unit," "factory-mounted controls," or "unit manufacturer provided controls," etc. within this section). "BAS Components" includes BAS controllers and operator interface software. Acceptable manufacturers of dampers, valves, actuators, sensors, and other field devices are to be as specified in Section entitled Automatic Control Systems.

2 PRODUCTS

2.01 MATERIALS

- .1 Use new products manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts are to be available for at least 5 years after completion of this contract.

2.02 BAS ARCHITECTURE AND GENERAL REQUIREMENTS

- .1 BAS using a client server architecture based around a modular PC network, utilizing industry standard operating systems, networks and protocols, and meeting system manufacturer's general requirements.
- .2 BAS is to include, but not be limited to, following:

- .1 custom built graphics including an overview, floor plans, individual graphics for each system, and summary graphics for system comfort and major equipment operation;
 - .2 high speed, peer to peer network of DDC controllers, a control system server, and web-based operator interface;
 - .3 utilize distributed control and not rely on any single controller;
 - .4 software designed around open standards with the control system server being accessible using a web browser over control system network, Owner's LAN or over the internet, and requiring no special software other than web browser to access system information;
 - .5 utilize BACnet protocol for communication to operator workstation, web server and controllers and designed around ANSI/ASHRAE BACnet Standard 135;
 - .6 open system architecture is to allow system to integrate to multiple vendors;
 - .7 capable of future expansion through addition of control devices, DDC controllers and/or operator devices, and is to include capability of 25% expansion.
- .3 Each NC is to have a spare Ethernet/IP port connection for local connection of an operator interface.
 - .4 Each BAS controller is to continue to execute its control software, sample input points, and update output points without connection to its BACnet/IP or MS/TP network or an operator interface. If global variables such as OAT are used within a controller's programming/sequence of operation, the global variable is to maintain its last value prior to network disruption.
 - .5 BAS is to be remotely accessible via an internet connection coordinated with Owner and reviewed with Consultant.
 - .6 Point termination types include:
 - .1 analogue input (AI) - thermistor, 0-10 VDC or 4-20 mA DC;
 - .2 binary input (DI) - monitoring of dry contacts, including contact closure "pulses" up to 10 per second;
 - .3 analogue output (AO) - 0-10 VDC, 0-20 VDC or 4-20 mA DC;
 - .4 binary output (DO) - 2-state DC voltage signal or magnetically held dry contact closure.
 - .7 Each BAS controller is to be able detect a changeover to battery-backed power and modify state of control program, if required by sequence of operation.
 - .8 Upon reestablishment of power to a BAS controller, devices are to return to normal operation in less than one minute.
 - .9 Server computer and operator workstation hardware capable of interfacing to an IEEE 802.3 Standard Local Area Network (LAN), and also capable to operate using IEEE 802.11 Wireless Local Area Network (WLAN).

.10 Digital Communications to 3rd Party Controls

- .1 BAS is required to send/receive information via digital communications technologies (i.e. Ethernet/IP, or EIA-485) and application protocols (i.e., BACnet, or Modbus) to specified "3rd Party" controls provided under other sections of this specification (e.g., VFD's, Chillers, etc.).
- .2 Following table details equipment packaged with a DDC controller supplied by equipment manufacturer (therefore supply of controller is not within scope of this section) and gateway provided with packaged equipment:

Packaged Equipment	Native Communication Protocol	Gateway Communication Protocol
RTU		
Split Units		

- .3 Following table details equipment packaged with a DDC controller supplied by equipment manufacturer (therefore supply of controller is not within scope of this section) but not supplied with a BACnet gateway:

Packaged Equipment	Communication Protocol

- .4 Refer to specification sections of equipment involved (e.g., VFD, Chiller, etc. section) for type of communications technology/interface (e.g., data link layer protocol) and application protocol used by each of 3rd Party controls, and for list of data to be shared with these controls.
 - .5 Communications not requiring a BAS Gateway (i.e., BACnet) - Design BAS to include NC's and sufficient EIA-485 communications ports (for MS/TP) to support communications and data handling capacities required.
 - .6 Communications Requiring a Network Controller "Driver" (e.g., Modbus) - Design BAS to include NC's and sufficient EIA-485 communications ports (for Modbus-RTU), and any optional software "drivers" and/or hardware if necessary to support communications technology and application protocol gateway interfaces.
 - .7 Communications Requiring a Gateway (e.g., LonTalk) - Design BAS to include sufficient BACnet/IP-communicating devices, with sufficient LonTalk communications capacity to support LonTalk 3rd Party devices.
- .11 System is to perform following general functions:
- .1 building management and control;

- .2 monitoring and control of controllers, remote devices and programmable logic controllers including sensors, actuators, environmental delivery systems (chillers, boilers, room climate control, lighting systems, electrical systems etc.);
- .3 operator interface to allow general supervision of room controls;
- .4 video display integration;
- .5 data collection and historization;
- .6 alarm management;
- .7 trending;
- .8 report generation;
- .9 network integration;
- .10 controller scheduling;
- .11 data exchange and integration with a diverse range of other computing and facilities systems using industry standard techniques.
- .12 In event of a power failure or disconnection from BAS, controllers are to continue to be fully operational with full time program capability.

2.03 NETWORK CONTROLLER (NC)

- .1 NC is a BTL listed BACnet B-BC device in accordance with following requirements:
 - .1 non-volatile memory for operating system software;
 - .2 read/write memory for custom control programming, trending, and alarming;
 - .3 real time clock;
 - .4 integral point or point expansion terminations;
 - .5 communications support to other NC's;
 - .6 minimum Quad Core 996Ghz processor;
 - .7 global control algorithms and automated control functions to execute using a 64-bit processor;
 - .8 minimum of 1 GB of DDR3 SDRAM on a 533Mhz bus;
 - .9 EIA-485 ports capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus;
 - .10 provide normal seven-day scheduling, holiday scheduling and event scheduling;
 - .11 logging capabilities for any object type with sample time interval adjustable at operator workstation;

- .12 alarm generation for any object change of value or state;
- .13 built-in, user-configurable demand limiting of energy.
- .2 Each BACnet MS/TP LAN to support a minimum of 50 BACnet devices.
- .3 NC Communications Network: 100baseT Ethernet minimum communications with BACnet/IP support for interconnection to other NC's, operator interfaces, and to an Internet/Intranet connection, if specified.
- .4 Web-Server: Password-protected access directly to controller to view, diagnose and modify operating features/parameters using a web browser with factory provided web pages used for this capability that require no setup other than required for programming controller.
- .5 NC is to provide:
 - .1 Communications support as "master" to up to 3 separate 76.8Kbps minimum BACnet MS/TP data link layer communications connections for advanced application and application specific controllers.
 - .2 BACnet Clause 6 Routing (between specified NC's and controller network technologies) and BACnet/IP Broadcast Management (BBMD).
- .6 NC is to be of scalable design such that number of trunks and protocols may be selected to fit specific requirements of a given project.
- .7 Controller to be capable of running up to six independent control strategies simultaneously. Modification of one control strategy does not interrupt function or runtime others.
- .8 Controllers for critical applications are to be B-BC controllers with IP connectivity.

2.04 FIELD EQUIPMENT CONTROLLERS (FEC)

- .1 Advanced Application Controller (AAC)
 - .1 BTL listed BACnet B-AAC device with:
 - .1 non-volatile memory for operating system software;
 - .2 read/write memory for custom programming;
 - .3 76.8Kbps minimum BACnet MS/TP communications;
 - .4 direct point termination through integral point connections;
 - .5 communications support for operator interface and controller network.

- .2 Application controllers to include universal inputs with 12-bit resolution that accept 3K and 10K thermistors, 0–10VDC, Platinum 1000 ohm RTD, 0–5VDC, 4–20mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller to include binary and analog outputs on board. Analog outputs with 12-bit resolution to support either 0–10VDC or 0–20mA. Binary outputs to have LED indication of status. Software to include scaling features for analog outputs. Application controller to include 20VDC voltage supply for use as power supply to external sensors.
- .3 Controller to also include support and modifiable programming for interface to intelligent room sensor with digital display.
- .4 All program sequences to be stored on board application controller in EEPROM. No batteries are to be needed to retain logic program. Program sequences to be executed by controller up to 20 times per second (minimum of 10 times per second) and capable of multiple PID loops for control of multiple devices. Calculations to be completed using floating-point math and system to support display of all information in floating-point nomenclature at operator's terminal.
- .5 Programming of application controller to be completely modifiable in field over installed BACnet LANs or remotely using modem interface.
- .2 Application Specific Controller (ASC)
 - .1 BTL listed BACnet B-ASC device dedicated for use with specific equipment and applications, and provided with:
 - .1 non-volatile memory for operating system software;
 - .2 read/write memory for all other purposes;
 - .3 factory-provided control software;
 - .4 76.8Kbps minimum BACnet MS/TP controller network connection (as an MS/TP master);
 - .5 integral point termination;
 - .6 communications support for operator interface, and controller network.
 - .2 Application controllers to include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller to also include binary outputs on board. For applications using variable speed parallel fans, provide a single analog output selectable for 0-10 V or 0-20 mA control signals. Application controller to include microprocessor driven flow sensor for use in pressure independent control logic. All boxes to be controlled using pressure-independent control algorithms and all flow readings to be in LPS (CFM).
 - .3 Controller to also include support and modifiable programming for interface to intelligent room sensor with digital display.

- .4 Program sequences to be stored on board application controller in EEPROM. No batteries are to be needed to retain logic program. Program sequences to be executed by controller 10 times per second and be capable of multiple PID loops for control of multiple devices. Programming of application controller to be completely modifiable in field over installed BACnet LANs or remotely using modem interface. Operator to program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller to be programmed using same programming tool as Building Controller and as described in operator's workstation section. Programming tools to be provided as part of system.
- .5 Do not use application specific controllers for systems/equipment that require custom application programming to meet sequence of operation (i.e., if an application specific controller is used, factory-provided control software/program is to perform sequence of operation without "upper level" control from another BAS controller).
- .6 Include an integral differential pressure sensor for controllers used for air flow measurement and an optionally integral damper actuator.
- .3 FEC's for terminal units to be provided by terminal unit manufacturer.
- .4 FEC's for Variable Air Volume (VAV) Terminal Units:
 - .1 FEC's for VAV terminal units are to comply to above requirements and following additional requirements:
 - .1 On-board flow sensor is to be microprocessor-driven and pre-calibrated at the factory. Pre-calibration is to be at 16 flow points as a minimum. All factory calibration data is to be stored in non-volatile memory. Calibration data is to be field adjustable to compensate for variations in VAV box type and installation. Operator's workstation, portable computers, and special hand-held field tools are not to be needed for field calibration.
 - .2 All calibration parameters are to be adjustable through intelligent room sensor.

2.05 REDUNDANCY

- .1 Hot Backup Server
 - .1 System capable of running a pair of similarly configured computers in a hot backup configuration where at any point in time one is acting primary and other acting as hot backup, and supporting real time on-line database duplication mechanism performing database duplication on a per-transaction basis. Simply scanning I/O on 2 separate systems and processing independently is not acceptable.
 - .2 System capable of removing one of the redundant systems for maintenance without interrupting operation, and upon its reinstatement, re-synchronize databases, again without interruption to system operation. Include method of manually initiating a fail over to assist with such maintenance operations.
 - .3 Announce failure of either system audibly and visually via alarming subsystem.
 - .4 To accommodate recoverable faults, failed system is to reboot automatically after non-fatal errors and assume role of acting as hot backup automatically.
- .2 Communications Redundancy

- .1 System capable of supporting fully duplicated communications links to operator workstations and field devices that support this type of connection.
- .2 Ability of system and associated operator workstations to connect to 2 fully independent Ethernets run in parallel. No repeater or bridge connection between Ethernets is acceptable as a means of achieving this function.
- .3 Ability of operator workstations to switch automatically between the 2 server computers in the event of a fail over, and switching between 2 Ethernets automatically in event of an Ethernet failure.

2.06 DISTRIBUTED SYSTEM SERVERS

- .1 Method for monitoring and control of points on remote BAS servers, specifically, real-time and history values. Features supported include:
 - .1 Global access to data, such that users at operator workstations on one server can access data, history, point detail displays, etc. for points on any other server. It is not to be necessary to configure system wide, more than one point for each data value or signal, regardless of number of servers accessing data.
 - .2 Ability to nominate sets of points to be accessed on a server-by-server and user-by-user basis. Mechanism is to be same as mechanism to control individual operator and workstation access to data for single server systems.
 - .3 Operators and workstations at any server are to see alarms from any other server, and not necessary to configure alarms more than once, regardless of number of servers accessing data.
 - .4 Ability to configure real time and historical trends that combine data from any connected server on a single trend, and not necessary to configure more than one point for each data value or signal, regardless of number of servers accessing data.
 - .5 Graphics, reports, and applications at a server have same distributed access to data on other servers as described above for operators and workstations, and not necessary to configure more than one point for each data value or signal, regardless of number of servers accessing data.
 - .6 Important service oriented architecture (SoA) web services enabling extension of BAS system providing seamless access to points, alarms and history from any distributed system server, without needing to directly address each individual server. Data across distributed system servers is to be seamlessly integrated into Web services.
- .2 System to support identical point names on any of the connected servers in distributed system. With exception of scope of responsibility assignment, there is to be no engineering effort to connect these distributed systems.
- .3 Connections between servers can be made through local Ethernet connections, plant's LAN, or corporate WAN. Connections are optionally redundant. Both redundant and non-redundant servers must be supported, and no additional engineering effort is to be required to connect both kinds of servers.

2.07 OPERATOR WORKSTATION

.1 N/A

2.08 COMMUNICATIONS

- .1 Capable of supporting greater than 90 separate communications links to networks of control devices. Each connection operates independently of the others and facilities are to be provided by system displays to individually place these links in service or out of service.
- .2 Given sufficient level of system privilege, it is to be possible to view, manipulate and analyze all data in the system from any operator workstation in system, including those operating remotely.
- .3 Once a control device is configured and placed in service, system is to automatically begin background diagnostic scanning of device to ensure communications are monitored independently of any monitoring scanning.
- .4 System is to perform checks on data integrity of all data acquired from device. If an invalid or time-out response is received, data is to be ignored and system will record transaction as an error. Statistics are to be kept and displayed by system on errors encountered in communication by means of a communications barometer. Barometer is to increment for every failed call and decrement for each successful call. In addition, system is to alarm separate marginal and failure conditions based on user-defined limits to advise operator of device and link that has failed. Communications statistics are to be displayed as standard on system and also be available as part of reporting system or custom displays.

2.09 SYSTEM SOFTWARE

- .1 Base BAS system server around Microsoft Windows 64-bit multi-tasking environment (minimum Windows Server 2008 Server). BAS system is to be a true 64-bit application to take advantage of Microsoft Windows enabling technologies. Any 16-bit system running on Microsoft platform (such as those originally based on MS-DOS and Microsoft Windows 3.x) are not acceptable.
- .2 Standard services supported by server computer operating system include following:
 - .1 multi-tasking multi-user support;
 - .2 real time and relational databases to integrate connected systems into unified presentation layer;
 - .3 BAS application software.
- .3 Networking software using industry standard TCP/IP LAN protocol.
- .4 Server computer or an alternative network connected computer is to be capable of acting as a file server for graphic displays and real time databases. LAN connected operator workstations are to be able to view custom displays and photo images from server computer.
- .5 System peripherals capable of being connected to server computer via LAN.

2.10 SYSTEM SUPPORT FOR VIRTUALIZATION

- .1 BAS system qualified and supported on a leading Virtual Machine platform such as VMware ESX, including support of operations of BAS server software, and also related communications gateways and storage devices.
- .2 Completed test plans demonstrating offered BAS solutions support for Virtual Machine platforms and characterizations of performance results and required Virtual Machine settings are to be available.

2.11 OPERATOR INTERFACE

- .1 Operator interface allowing for efficient communication of operational data and abnormal conditions, providing a consistent framework for viewing of information, and following requirements:
 - .1 critical areas (such as alarm icons) visible at all times;
 - .2 predefined area on screen providing operator messaging visible at all times;
 - .3 set of standard displays for configuration, and navigation around BAS system provided with every system and not requiring any engineering;
 - .4 unlimited number of custom (facility specific) displays created to meet needs of specific facility.
 - .5 software capable of running in Windows Server environment of version recommended by manufacturer;
 - .6 interactive and totally graphics and/or icon based, capable of supporting at least 65,000 colours at a minimum 1280 x 1024 pixel resolution;
 - .7 employ standard Windowing conventions so as to reduce required operator training, in particular, standard, totally configurable tool bar icons and drop-down menus available on standard and custom displays to allow easy access to common functions, and such functions also available via a standard set of function-key based pushbuttons without requiring configuration;
 - .8 support ability to "full screen lock" window so users cannot access other applications, and if "full screen lock" is not enabled, support for copy and paste facilities are to be provided between operator window and other Microsoft applications;
 - .9 operator interface connection:
 - .1 flexible in its connection to BAS server;
 - .2 Ethernet LAN or Internet connection used between server and operator workstations and browser clients;
 - .3 provide standard remote access support using industry standard tools like VNC, RADMIN, and Windows Terminal Services;
 - .4 where used, remote connections are to use password protected user authentication and encrypted network/internet protocols.
 - .10 following functions performed through operator interface:

- .1 display and control of field equipment;
 - .2 acknowledge alarms on a priority basis;
 - .3 initiate printing of reports;
 - .4 archive and retrieve event logs;
 - .5 view historical plant information on predefined trend windows;
 - .6 view intranet or information from the Internet in a secure environment;
 - .7 change own password;
 - .8 monitoring of data communications channels;
 - .9 configure system parameters.
- .2 Web Browser Operator Interface
- .1 Operator interface fully available and functional through internet via an Internet Explorer browser allowing an operator to operate facility and perform all functions on same standard and custom graphics as used in standard operator interface. Custom graphics, alarm graphics and standard graphics available without modification or reengineering through Internet in an Internet Explorer browser user interface.
 - .2 Browser interface providing login and security authentication in same way as standard operator interface. Large number of casual users permitted without any additional licensing burden with licensing based on number of simultaneous operator connections on a "first come first served" basis. Users with casual access are to automatically disconnect from BAS server after an idle timeout period.
- .3 Operator Interface Characteristics
- .1 Following minimum capabilities are standard and require no custom programming or scripting:
 - .1 window re-size, zoom in, zoom out with display resolutions continuously resized to fit available window size;
 - .2 dedicated icons and pull down menus to perform multiple operations.
 - .2 Operator Input Devices
 - .1 Operator interface capable of being mouse driven and simultaneously support keyboard data input. Both fixed menus and configurable function keys supported to aid novice and experienced operator respectively. Interface also capable of supporting a touch-screen for pointing and command input.
 - .2 Utilizing a Tool Bar for common operator commands, and able to request display of commonly used displays and activate system functions via drop-down menus.
 - .3 Operator interface input is possible using only pointing device and QWERTY section of keyboard.

2.12 OPERATOR SECURITY

- .1 If necessary, each operator may be assigned a user profile that defines following:
 - .1 security and/or control level;
 - .2 operator identifier;
 - .3 unique encrypted password;
 - .4 operator scope of responsibility assignment;
 - .5 start graphic for that operator;
 - .6 timeout value for that operator.
- .2 Log actions initiated by operator in event database by operator identifier. In addition, any control actions to a given point are only allowed if control level configured in operator's profile exceeds level assigned to controlled point.
- .3 System to support at least 6 levels of operator security.
- .4 Sign-On/Sign-Off
 - .1 Operator is permitted to sign on to system if correct operator identity and password have been entered. It is possible to have system authentication integrated directly into Windows, Windows Group Accounts, or an LDAP Server such that operator uses pre-existing account details to sign on to BAS system ensuring operators only need to remember 1 set of credentials for both their workstation and BAS.
 - .2 Each operator is to be assigned a password and a defined scope of responsibility which defines locations in facility that may be managed and controlled by individual operator.
 - .3 Operator may sign-off at any time by issuing a sign-off command.
- .5 Location Assignment / Scope of Responsibility Profile
 - .1 Each operator is to be assigned one or more specific areas of building with appropriate monitoring and control responsibility (no view, view only, alarm acknowledge only or full control). Location is defined in this context as a logical entity comprising of a set of points in system. This in turn may represent a physical space in building. Locations are used to partition BAS database in such a way as to assign operators control over certain areas and prevent unauthorized access to other areas.
- .6 Duress
 - .1 System to support operator duress function, so operator may discretely indicate they are signing in to BAS system under duress. System is to recognize operator is signing on under duress and be able to issue a control to alert appropriate assistance.
- .7 Command Partitioning

- .1 Possible to assign each operator a set of allowed commands for each assigned location. Commands can be mapped against output state of any given digital point in respective area to determine whether a control command is allowed for particular operator.
- .2 With this feature, it will, for example, be possible to configure an operator to set a digital point to "on", but to disallow same operator from setting same digital point to "off".

2.13 STANDARD SYSTEM DISPLAYS

- .1 Following displays are to be included as part of system:
 - .1 alarm summary display;
 - .2 event summary display;
 - .3 point detail template displays (for each point in database);
 - .4 trend set template displays;
 - .5 group control and group trend template displays;
 - .6 communications status displays;
 - .7 system status displays;
 - .8 face plates for all common point types;
 - .9 configuration displays.
- .2 In the case of trend and group displays, configuration of these displays only require entry of a point name to completely configure display. Alarm summary, event summary, point detail, communications status, and system status do not require any configuration.
- .3 System Status Display
 - .1 Available on each operator workstation and automatically built by BAS system, requiring no engineering to add additional devices to be monitored. It is to display following information in a hierarchical system tree:
 - .1 points in alarm condition pending "acknowledge" command;
 - .2 points which remain in an alarm state but which have been acknowledged;
 - .3 communication failures;
 - .4 printer status;
 - .5 operator workstations status;
 - .6 communication links status;
 - .7 controller status;

- .8 system interfaces status;
- .9 additional connected server status.
- .4 Administration Displays
 - .1 System is to provide following full screen displays:
 - .1 master system menu;
 - .2 report summary;
 - .3 alarm summary;
 - .4 event summary;
 - .5 display summary;
 - .6 system status display;
 - .7 system parameters configuration;
 - .8 operator workstation configuration;
 - .9 scope of responsibility assignment;
 - .10 time schedule assignment;
 - .11 calendar assignment (holidays/special occasions);
 - .12 history assignment;
 - .13 push-button assignment;
 - .14 operator definition;
 - .15 operator message board;
 - .16 events archive and retrieval;
 - .17 time period summary and configuration;
 - .18 point detail for every configured point.

2.14 CREATING CUSTOM DISPLAYS

- .1 Graphic Display Building Editor
 - .1 Include a graphic display building editor for creation of site specific graphic displays allowing one-step online building of display static and dynamic objects. It is a WYSIWYG editor (what you see is what you get) allowing displays drawn using editor to appear exactly same when viewed from an operator workstation.

- .2 Displays are created in HTML 5 (Hypertext Markup Language) format. This is essential so displays can also be viewed through a web browser as well as normal BAS operator interface. Displays are to be saved in standard HTML format. Graphic elements are to be available as HTML elements. It is not acceptable to have an HTML format which merely links to a proprietary object or bit map of entire display. It is to be possible to view and edit resulting HTML file using a text editor. Systems which do not support HTML displays are not acceptable.
- .3 It is to be possible to link dynamic objects to BAS database. They are to allow information to be displayed from database or to allow an operator to interact with them in order to make changes in database and to perform control actions. Dynamic objects are to include dynamic text, push buttons, indicators, charts, check boxes, combo boxes, pop up boxes, ActiveX controls and scroll bars.
- .4 Graphic display building editor to support multiple features including but not limited to following:
 - .1 one step display building (both background and dynamic information);
 - .2 point and click operation;
 - .3 paste to and from Clipboard;
 - .4 control for display status of system schedules;
 - .5 configurable tool, colour and line palettes;
 - .6 dialog boxes for definition of object properties;
 - .7 import graphics from 3rd party packages including WMF, BMP, TGA, GIF and JPEG formats;
 - .8 standard library of BAS industry objects;
 - .9 live video element;
 - .10 ActiveX controls;
 - .11 ActiveX documents;
 - .12 display scripts written in either JavaScript or VBScript;
 - .13 multilevel undo and redo;
 - .14 transparent images;
 - .15 popup displays;
 - .16 standard alarm symbols;
 - .17 real time and historical trend object supporting up to 32 points on 1 trend.
- .2 Display Scripting

- .1 It is to be possible to further animate display elements using standard HTML scripts such as JavaScript or VBScript. Include script editor supporting one of standard script languages. By using script programs, individual elements on display may be manipulated. Proprietary scripting language or additional scripting and drawing package is not acceptable.
- .2 It is to be possible to perform a variety of animations.
- .3 Live Video
 - .1 Both graphic display building editor and operator interface are to have built in support for creation and display of live video objects without need for programming. Size and position of video object is configured on a per display basis.
- .4 Web Technology
 - .1 Displays created in graphic display building editor are to be usable in a web browser such as Microsoft's Internet Explorer without modification. Displays are to be usable in this manner enabling operators to completely operate system through a web browser via internet. Displays may also incorporate data from intranet, Internet, or ActiveX documents along with other building data.
- .5 Launching External Applications
 - .1 It is to be possible to launch applications (such as Microsoft Word, Excel, custom help files or any 3rd party applications) from a custom display. If supported by application, it is to be possible to launch application with a specified file opened within launched application. Launching of such applications is to be possible from operator workstation pull down menus or from a push button on a custom display.

2.15 MONITORING AND CONTROL

- .1 System is to support acquisition of data using following techniques:
 - .1 periodic scanning;
 - .2 report by exception;
 - .3 data on demand.
- .2 In order to minimize communications traffic, system is to automatically group together data requests using contiguous addresses and scan intervals to generate scan packets, optimizing throughput for a given scanning load. System is to provide utilities to examine scan packet allocation for each scan interval, and compile aggregate statistics on communication link usage.
- .3 Where supported by controlling device, use Report by Exception (RBE) protocols to reduce scanning load of system while improving system response. If necessary, periodic scanning may be used in conjunction with RBE to ensure data integrity.
- .4 Device Control

- .1 Communicate control transactions issued by operator to control devices using a write followed by read to ensure integrity of transaction. If read following write to device indicates control action has failed, inform operator by means of a control failure alarm. Priority of control failure alarm is to be configurable by user.
- .2 Include option to assign a control confirmation message to individual points. Message is to request operator confirm requested supervisory control action prior to sending entered value to controller.
- .5 Single Signature Control
 - .1 Include option to provide an additional level of control by enforcing sign-off of certain controls with single signature control. Single signature requires operator to re-enter their operator identity and password along with selecting a reason for issuing the control ensuring a control is performed by nominated operator and logged for future reporting purposes in event summary.
 - .2 Following items require single signature control:
 - .1 ;
 - .2 .
- .6 Double Signature Control
 - .1 Include option to provide an additional level of control by enforcing sign-off of certain controls with double signature control. Double signature requires operator to re-enter their operator identity and password along with selecting a reason for issuing the control, and a supervisory operator must also enter their operator identity and password to confirm operation.
 - .2 Following items require double signature control:
 - .1 ;
 - .2 .

2.16 SYSTEM DATABASE

- .1 System is to provide a real-time database incorporating data from analogue, logical or pulse inputs. Database is to be configurable by end user without need for any programming and able to be modified on-line without interrupting operation of system. In addition to point-based information, database is to provide historization capabilities for analogue, digital, pulse and event based information. Information is to be accessible by all facilities of system such as custom displays, reports, trends, user written applications, etc.
- .2 Database Structure
 - .1 Real-time database is to support collection of data and storage using following structures:
 - .1 access point structures;
 - .2 analog point structures;

- .3 status point structures;
 - .4 accumulator point structures;
 - .5 flexible point structures;
 - .6 historical data structures;
 - .7 event data structures;
 - .8 user defined structures.
- .2 Point database structures are to be comprised as a composite point with a number of associated parameters, which may be referenced relative to a single tag name. Specifically, each of these parameters are to be accessible by various sub-systems such as graphical operator interface, report generation system and application program interface in a simple POINT.PARAMETER format without the need to know any internal storage mechanism.
- .3 System is to maintain portions of database requiring frequent high-speed access as memory resident information and other less frequently accessed data as disk resident data. Memory resident data is to be checkpoint to disk every minute to minimize loss of data in the event of loss of power or other system failure.
- .4 Database backup is to be possible with system on-line, including backup of historical based data, via standard Microsoft Windows operating system utilities.
- .5 Store point data in a composite point database structure that provides a wide range of configurable information including but not limited to:
- .1 point name and description;
 - .2 multiple locations for data storage and device scanning addresses;
 - .3 scan period;
 - .4 multiple types and instances of alarms;
 - .5 multiple deadband or hysteresis settings (analog points);
 - .6 monitoring and control access restriction information;
 - .7 location of operator alarm handling instructions;
 - .8 location of ancillary information associated with the point;
 - .9 list of recent events pertaining to that point.
- .6 Points are to display all recent events on their point detail displays, using a direct link to BAS event system.
- .7 BAS system is to provide a means by which a number of alarm inputs, outputs and other related points can be grouped together for more convenient monitoring and control without need for custom graphics.

2.17 HISTORY MANAGEMENT

- .1 Collection of historical point data is to be configurable as part of point definition. Once configured, historical data is to be collected automatically. Historical data collection is to be provided for both snapshots and averages with intervals ranging from 1 second to 24 hours.
- .2 Once assigned to history, point data is to be available by POINT.PARAMETER access used in conjunction with a history offset to locate particular value of interest. Graphical operator interface, trend, report generation and application interfaces are to be able to access historical data.
- .3 Modifications to history collection of a point is to be possible on-line without loss of previously collected data for point being changed or any other points in system currently being historized.
- .4 History is to be easily configurable to be archived to an alternative file system or offline media. Different archive settings are to be available for different history types.

2.18 TRENDING

- .1 System is to provide flexible trending allowing real-time, historical or archived data to be trended in a variety of formats. Include ability to combine trend data types to allow for comparisons between data e.g. current real-time data versus archived data. In addition, event database information is to be available for comparison and analysis purposes in same display and allow filtering of event data display based on time and location.
 - .1 Trend is to support annotations with system events within one display window, allowing operators to view historical plant information in a real time window with system events. Include support for filtering events by location and other standard filters available within event management system.
- .2 Trend Types
 - .1 Present real-time, historical or archived data in a variety of formats, including single, dual and multiple value trends of up to 32 points.
 - .2 Allow operator to display trend data in multiple different views.
 - .3 Operators are to be able to zoom in on information displayed on trend sets for closer inspection by dragging out an area of interest with mouse or other pointing device.
 - .4 Scroll bars as well as time selectors for direct entry of beginning and ending times are to be available to move trend set backwards and forwards across historical records.
 - .5 It is to be possible to embed trend objects as part of custom displays in multiple formats.

2.19 EVENT MANAGEMENT

- .1 As a standard function, BAS is to log events automatically into a relational database. Journal is to contain following event information:
 - .1 alarms;

- .2 alarm acknowledgements;
 - .3 return to normal;
 - .4 operator control actions;
 - .5 operator login and security level changes;
 - .6 on-line database modifications;
 - .7 communications alarms;
 - .8 system restart messages;
 - .9 database changes.
- .2 Event database entries are to contain following information as a minimum:
- .1 time and date stamp;
 - .2 database partition code;
 - .3 source;
 - .4 operator;
 - .5 event type;
 - .6 condition;
 - .7 action;
 - .8 alarm priority;
 - .9 description;
 - .10 value;
 - .11 engineering units;
 - .12 comments.
- .3 Events may be sorted by time and date, database partition or source of event. It is to be possible to apply filters to list of events to limit view of events to those which match filter. Filters may include multiple dimensions and wildcards and also able to be saved and restored for reuse.
- .4 Event management system is to be fully integrated with standard reporting system. System is to automatically reference restored archive file if a report is requested containing a time search window covered by current archive file.
- .5 Operator is to be able to restore previously archived files and review or print them from operator workstations.

- .6 It is to be possible to directly generate an event report from event database filtered online without using reporting system.

2.20 ALARM MANAGEMENT

- .1 BAS is to support several different types of alarms for analogue points, including:
 - .1 high alarm;
 - .2 high-high alarm;
 - .3 low alarms;
 - .4 low-low alarm;
 - .5 deviation high alarm;
 - .6 deviation low alarm;
 - .7 rate of change alarm;
 - .8 unreasonable value alarm.
- .2 Any of these alarms are to be assignable to each analogue or accumulator point on an individual point basis as part of point configuration process.
- .3 Status points are to allow each individual state to be alarmed.
- .4 Alarm Priorities
 - .1 Each monitored point in system is to be able to be assigned one of 4 alarm priorities to individual states. Meaning of priorities are as follows:
 - .1 Journal - Changes of state are journalized to alarm/event log and optionally printed on alarm/event printer.
 - .2 Low - Change of state will generate a low priority alarm, which will appear on alarm summary. Optionally, alarm may be printed on alarm/event printer or generate an audible tone.
 - .3 High - Change of state will generate a high priority alarm, which will appear on alarm summary. Optionally, alarm may be printed on alarm/event printer or generate an audible tone.
 - .4 Urgent - This is highest priority. Change of state will generate an urgent priority alarm, which will appear on alarm summary. Optionally, alarm may be printed on alarm/event printer or generate an audible tone.
- .5 Alarm Enunciation
 - .1 Alarms are to be enunciated by:
 - .1 most recent, highest priority alarm message appearing on dedicated alarm banner on operator interface;

- .2 alarm message appearing on alarm summary display;
 - .3 available tone based on a "*.wav" or other sound file for each alarm priority;
 - .4 alarm message printed on alarm printer;
 - .5 alarm indicator flashing on operator interface.
- .2 Indicate alarm conditions in a clear unambiguous manner, and indicate unacknowledged alarms differently to acknowledged alarms.
- .3 Enunciate alarms at operator workstation even if there is no operator currently signed-on.
- .4 Points are to be enunciated while in alarm. If a point is set to alarm inhibited, point is to no longer cause annunciation. If a point goes into an alarm state whilst inhibited and then is still in alarm state when point is set to alarm enabled, point is to immediately cause annunciation.
- .6 Alarm Processing
 - .1 Assigning an alarm to point is to automatically cause system to perform following actions when an alarm occurs:
 - .1 alarm is to be time stamped to nearest second and logged in event database with point name (source), alarm type, alarm priority, point description, new value and engineering units;
 - .2 point value which is in alarm is to turn red (or other configurable colour) and flash on any standard or custom display which uses that point;
 - .3 unacknowledged alarm entry is to be made in system alarm summary for low, high and urgent alarms;
 - .4 audible alarm is to sound (if configured);
 - .5 alarm annunciation indicator is to flash synchronously on all displays.
 - .2 In addition, alarm banner of operator interface is to show most recent (or optionally oldest), highest priority, unacknowledged alarm in system.
- .7 Alarm Summary
 - .1 Shows current or pending alarms on system including following requirements:
 - .1 standard summary display requiring no engineering to setup and commission;
 - .2 support filtering by time and date, database partition or source of alarm;
 - .3 capable of displaying a summary of current alarms by location as well as highest priority alarm within corresponding location, and ability to be filtered based on selected locations from location pane;
 - .4 recurring alarm counter:

- .1 support a simple method to reconcile recurring alarms into a common alarm message preventing nuisance alarms from flooding alarm summary display;
 - .2 when same alarm from a plant device recurs, alarm display is to use a counter to represent how many times this alarm has occurred since last acknowledged;
 - .3 alarm consolidation is to minimize alarm messages for operator, but BAS will always track each new alarm into event subsystem thereby ensuring alarms are present regardless of how often they have recurred.
- .8 Dedicated Alarm Banner and Alarm Indicator
 - .1 Dedicated alarm banner is to appear on all displays showing either most recent or oldest (configurable), highest priority, unacknowledged alarm in system. This banner is to be clear when there are no unacknowledged alarms for operator to process.
 - .2 Alarm indicator is to also appear on all displays. This indicator will flash red (or another configured colour) when there are any unacknowledged alarms pending in system. This indicator will remain solid red if there are alarms, which have not returned to normal but which have been acknowledged. Indicator will be clear if there are no points in an alarm condition.
- .9 Alarm Logging
 - .1 As well as being logged on printer, alarms are to be logged to an event file for future retrieval in alarm reports or archived to removable media.
- .10 Alarm Response Function Keys
 - .1 Following dedicated function keys are to be provided on keyboard for alarm action:
 - .1 Acknowledge - After moving cursor to point in alarm on screen and selecting point, operator is to be able to acknowledge an alarm by pressing this key. This action is to be logged in event file and on printer showing operator ID with alarm.
 - .2 Alarm Summary - By pressing a dedicated key at any time operator is to be able to view a display showing currently active alarms. Alarm messages are to be colour-coded showing priorities. Operator is to be able to view alarms according to priority or sorted based on other fields. It is to be possible to acknowledge alarms from this display and also go to associated display defined for point.
 - .3 Associated Display - After moving cursor to point in alarm on screen and selecting point, operator is to be able to bring up display applicable to that alarm by pressing this key. Just selecting associated display key directly will bring up associated display for point currently on alarm banner. This is generally a custom graphic showing location of alarm in facility.
- .11 Alarm Acknowledgement

- .1 On acknowledgement by operator, flashing indicator is to turn steady, and point value is to remain coloured with alarm priority colour, on any system or custom graphic. Acknowledgement is to also be logged in event database identifying operator or station that acknowledged alarm. If point goes out of alarm before being acknowledged by operator, alarm is to be shown by a different indication and remain in list until specifically acknowledged by operator. If a point is not acknowledged within a configurable period of time, then an additional alarm can be generated and reassigned to another location to allow other operators to take action.

.12 Alarm Filtering

- .1 Alarm summary is to be able to filter alarms displayed to operator by limiting view of alarms to those that match filter. Include use of columns on alarm summary as part of a filter allowing sophisticated filters to be configured e.g. alarms from this particular point, with this value, during this period. Filters may include multiple dimensions and wildcards. Filters are to be able to be saved and restored so previously configured filters can be reused. It should also be obvious to operators when a filter has been applied to alarm summary.

.13 Alarm Link to Digital Video Recordings

- .1 System is to allow linking and display of digital video recordings pertaining to alarms. If there is any video footage in digital format which is relevant to an alarm, then alarm summary is to indicate this by use of a special icon on alarm. By selecting icon, operator can then replay relevant digital video footage of alarm incident.

.14 Print Alarms as a Report

- .1 Filtered alarm summary should be able to be printed directly as a report. From alarm summary page, it is to be possible to view current filtered list of alarms via a print preview button. This shows what alarms will look like when printed to configured report printer. From alarm summary, it is to be possible to print alarms directly using print button.

.15 Additional Alarm Information

- .1 BAS system is to provide support for an additional message to be tagged to alarm. This message is to provide operator with additional information on alarm but is to not clutter alarm summary. It is to appear in a separate message summary at same time as alarm appears in alarm summary. Messages can be pre-configured and then simply attached to individual points by means of a message ID.

.16 Advanced Alarm Management

- .1 BAS is to be capable of advanced alarm management, which includes set stages of alarm handling. Stages are to be:
 - .1 silence alarm condition;
 - .2 acknowledge and action alarm condition;
 - .3 respond to alarm condition by using pre-defined responses;
 - .4 optionally reset alarm.

- .2 Record actions in event file for retrieval and auditing purposes.
- .3 When an alarm is silenced, an instruction page for alarm will be displayed. Alarm may then be acknowledged from this page and alarm handling action completed.
- .4 Once alarm is acknowledged and appropriate action has been taken, operator may move to response page to select from up to 100 user-defined responses to be logged in event file. Alternatively, operator is to be able to enter their own response, which will also be logged in event file. At same time, alarm is removed from alarm file. Optionally, point is to remain on alarm summary until a manual reset operation is performed.
- .5 It is to be possible to enable/disable this feature on a point-by-point basis given appropriate system privilege level.

2.21 REPORTING

- .1 Support a flexible reporting package to allow easy generation of report data. Reports provided are to include pre-configured standard reports for common requirements such as alarm event reports and custom report generation facilities configurable by user.
- .2 Reports are to be activated in one or more of following ways:
 - .1 periodic activation at user specified intervals;
 - .2 operator demanded;
 - .3 event initiated e.g. change in point value;
 - .4 application initiated;
 - .5 printed directly from the alarm/event summary.
- .3 Standard Reports
 - .1 Various pre-formatted reports are to be available on system.
 - .2 Configuration of these reports only require entry of schedule information, and other parameters such as point name or wildcard, filter information, time interval for search and destination printer to fully configure report. Specifically, no programming or scripting is required.
- .4 Access Level Report
 - .1 Lists access levels matching a specified search criteria filtered by zones and allocated time periods.
- .5 After Hours Report
 - .1 Produces a summary of alarms occurring during period specified by operator as "after hours".
- .6 Alarm/Event Report

- .1 Produces a summary of events of a specified type for nominated points occurring in a time period. Time period may be specified as an absolute start and end date and time, or as a period relative to current time. This report is to also be able to produce a summary of changes made by a specific operator.
- .7 Alarm/Event SQL Reporting Services Report
 - .1 This sample report lists a summary of alarms and events by location and by date and time. It includes a graphic summary.
- .8 All Points Report
 - .1 Produces a list of point information, including point name, description, point type, engineering units, and current values. Report configuration is to allow filtering based on a wide variety of criteria.
- .9 Operator Trail Report
 - .1 Produces a summary of operator actions relating to a specific operator in a specified period.
- .10 Point Trail Report
 - .1 Produces a summary of events of a specified type occurring in a period on nominated points.
- .11 Point Attribute Report
 - .1 Report is to be provided to points selected by one of following attribute criteria:
 - .1 out-of-service;
 - .2 alarm suppressed;
 - .3 abnormal input levels;
 - .4 in manual mode.
- .12 Point State Changes Report
 - .1 Lists information about time periods matching specified search criteria.
- .13 Time Period Report
 - .1 Lists information about time periods matching specified search criteria.

2.22 CUSTOM REPORTS

- .1 In addition to standard reports, configurable report generation facilities are provided allowing custom reports to be produced. They can be configured at any time with system online, and are able to access any database values. At least 3 methods of custom report generation are to be available.
 - .1 Microsoft Excel report;

- .2 ODBC format for purpose of extracting data and creating custom reports. It is to be possible to access tables of data from BAS through an ODBC compliant tool such as Crystal Reports or SQL Server.
- .3 SQL Reporting Services custom report.

2.23 USER DEFINABLE DATABASE

- .1 In order to support other types of data such as user entered or calculated data from application programs, system is to provide a user definable database area that can be fully integrated into system. Data contained in this database is to be accessible by:
 - .1 custom graphics;
 - .2 custom reports;
 - .3 application programs;
 - .4 network applications using a Network API.

2.24 POINT INITIATED PROGRAMS (PIPS)

- .1 In addition to standard point processing functions, system is to allow additional processing through use of standard PIPS that may be attached to any points.
- .2 PIPs are to be either configurable standard algorithms, or preference is a VBscript can be written as a library function and attached to points within BAS.

2.25 HISTORICAL DATA ARCHIVING

- .1 Support archiving of historical data allowing a continuous record of history to be built up over a period of time. Archived data may be stored on hard disk of system or a remote network drive or moved off-line to removable media such as DAT tape, or optical disk. Number of archives maintained on system before being transferred to off-line media is to only be limited by size of hard disk or remote network drive. Allow user to define specific intervals of history to be archived to avoid archiving of unnecessary data.
- .2 Once archived, data is to be available for re-trending through system trend facilities in combination with current on-line history or other archives. Providing archived history is present on BAS server's hard disk or remote network drive, trend facilities are to be able to access it transparently for display, when a user scrolls beyond current on-line history limits.
- .3 Support display of trend data from up to 10 years of age. Any required upgrades or updates to BAS system is to be capable of preserving historical information to enable review of data from any earlier release of system.

2.26 TIME SCHEDULES

- .1 Include ability to specify time schedules for control of BAS points and control a range of a single point to a large number of points from a single schedule. Single time schedule is to define control to any combination of day and time.

- .2 Scheduling management system is to be more flexible than providing weekly schedules with a provision for a finite number of special occasions/holidays, allowing schedules to be entered that recur on a non-weekly basis or only occur once on a given day in future.
- .3 Time schedule is to provide ability to override normal schedule for holidays or special occasions, and user is able to create multiple different grouping of dates (Calendars) that can be assigned to individual points as applicable.
- .4 Configuring time schedules is performed through a graphical user interface whereby operator selects appropriate time span from calendar. Systems where times and days are manually entered or managed by an external spreadsheet type form are not acceptable. User interface is to support capability of navigating to any future date to allow user to enter a time schedule. User interface is to provide graphical feedback to indicate various time schedule conditions.
- .5 Allow user to view time schedules that have been configured in past, present, and future in a graphical calendar interface, and increase or decrease amount of time on a schedule which is currently active.
- .6 Where control device supports an internal time schedule program, BAS is to upload, display, modify and download control device time schedules. Support for control device time schedules are to be in addition to BAS time schedules.

2.27 CONTROLLER SCHEDULING TOOL

- .1 Ability to create, edit and maintain controller time schedules. Controller scheduling tool constructed in a way that allows compatibility with new controller types with minimal additional development.
- .2 Allow downloading of schedules to several (supported) controllers in a single operation by provision of an integrated graphical interface.
- .3 Include a clear, graphical indication of status of each downloadable schedule element, and automatically recover and complete any schedule download which, for any reason, has failed or been interrupted.

2.28 OPEN INTEGRATION

- .1 Any of following Open Protocol Standards is to be used as necessary for integration of 3rd party devices or systems.
- .2 Modbus
 - .1 Include an integrated interface to devices using Modbus RTU protocol, where BAS server is to be 'master' and external device or system is to be "slave".
 - .2 Support user definable data formats for Modbus devices to accommodate wide variety of formats in use in industry.
- .3 BACnet (ANSI/ASHRAE 135)
 - .1 Capable of communicating to other building subsystems using ASHRAE standard BACnet, and capable of acting as both a BACnet operator workstation and a BACnet gateway and support various standard BACnet objects.

.4 BACnet Operator Workstation

- .1 Integrated BACnet operator workstation allowing monitoring of BACnet devices via data acquisition and control.
- .2 BACnet operator workstation is to support various BACnet Interoperability Building Blocks.

.5 BACnet Gateway

- .1 Integrated BACnet gateway allowing 3rd party BACnet clients to access data.
- .2 BACnet gateway is to support various BACnet Interoperability Building Blocks.

.6 OLE for Process Control (OPC)

- .1 Include an integrated OPC Client, integrated OPC Data Access Server, and OPC Alarm and Event Server.

.7 Data Exchange

- .1 Capability to interface to point database of other BAS systems (i.e. nodes) on a TCP/IP network enabling both acquiring of point data and issuing control outputs to and from connected BAS systems.

.8 Data Exchange with Microsoft Excel

- .1 Capable of exporting bulk data to Microsoft Excel.

2.29 ACCESSING BAS FROM 3RD PARTY WEB PAGES

- .1 Web-page controls and web server interface to BAS, which allows tenants or other users to monitor and control a variety of BAS-supervised functions via their own Web pages created for their own Intranet or Internet and viewed from a standard web-browser. For example, ability for building tenants to view floor graphics via a dedicated or existing building Intranet, and to be able to monitor and control floor lighting and ambient temperature information.
- .2 Include ability to limit web browser access to BAS facilities by means of standard web and networking techniques.

2.30 PAGING AND EXTERNAL ANNUNCIATION OF SYSTEM ALARMS

- .1 Include a facility for sending alarm text from configured points to following external systems:
 - .1 alphanumeric pagers;
 - .2 mobile phones with text message (SMS) support;
 - .3 email;
 - .4 SNMP message.

- .2 Each point's paging priority threshold is individually configurable, and individually enabled or disabled. Each external device configured in system is to have individually selectable times and days of operation, an alarm priority threshold, and an alternative device for use in escalation of unacknowledged alarms.

2.31 ACKNOWLEDGMENT OF REMOTE ALARMS RECEIVED FROM PAGING SYSTEM

- .1 For alarms received on mobile phones via SMS message, include ability to allow acknowledgement of these alarms via same SMS solution allowing remote users to clear alarm status thereby indicating alarm status has been received and acknowledged.

2.32 DATABASE CONFIGURATION TOOL

- .1 Database configuration tool, provided with BAS system, allowing configuration of point records, printers, controllers, and operator workstation connections. Utility is to be in the form of a relational database and operate in a true 64-bit graphical environment such as Windows Server of version recommended by manufacturer. Utility is to also have ability to export information to and import information from Microsoft applications such as Microsoft Excel.
- .2 Users with sufficient security access are to be able to configure database while system is on-line.
- .3 Ability to modify a range of communications and other parameters for each device.
- .4 Include features that reduce configuration time of BAS system. These features are to include adding multiple points, controllers etc. at once.
- .5 Support free format text fields, which user can use for additional information such as cabinet or wire numbers. These additional fields are to be simple extensions to existing items in database such as BAS points.
- .6 Database management reports are to be provided by utility as standard. Utility is to also provide support for ad-hoc reporting facilities for engineering use.

2.33 SERVER SCRIPTING ENGINE

- .1 Ability to extend its functionality easily by addition of small script code to certain server functions enabling additional customer specific functionality to be easily added to point, report and server processing. For example, a script is to enable a calculation to be performed and a number of points to be controlled based on another point going into alarm state. Scripts have ability to be attached to point processing, report generation, server start-up and shutdown, or executed on a periodic basis.

2.34 DIAGNOSTIC CAPABILITIES

- .1 Ability to perform easy diagnostics to check health of system.
- .2 Make diagnostic information viewable through an easy-to-use user interface and easily exported as a standalone collection of material for later analysis.
- .3 Capabilities are to include: ability to run automated tests, record reproduction of a failure, as well as collection and organization of available diagnostic information (files, logs, and system settings).

2.35 SMOKE AND CRITICAL PROCESS CONTROL

- .1 Ability for building management portion of BAS to provide control and monitoring of HVAC functions associated with smoke control and when used with appropriate hardware is to be listed by ULC under category UUKLC for this purpose. When used for critical process or other safety functions, such as boiler safety monitoring, system is to also be ULC listed for this purpose.

2.36 WIRING MATERIALS

- .1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in the appropriate Section(s) of the Electrical Work Division of the Specification.

2.37 ENCLOSURES

- .1 NEMA rated appropriate for location of equipment, for BAS components including controllers, sensors and other devices except space sensors. Refer to Section entitled Automatic Control Systems for additional requirements regarding local control panels.

3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Provide a complete building automation system in accordance with requirements of this Section, Section entitled Automatic Control Systems, drawings, and input/output points list(s).
- .2 Install BAS components and materials in accordance with manufacturer's instructions. Where drawings conflict with these instructions, submit a written request for clarification.
- .3 Coordinate installation with other trades to avoid field condition conflicts.
- .4 Electrical products and execution are to comply with requirements of applicable Electrical Division Sections.
- .5 Provide operator workstation in _____.
- .6 Provide web server in _____.
- .7 Provide sufficient number of BAS controllers to meet memory needs of project programming, alarming and trending along with minimum 25% spare capacity for future use.
- .8 Provide sufficient number of BAS controllers and point expansion modules to meet point needs of project.
- .9 For each system critical system listed below, provide an NC (instead of an FEC) and connect directly to the BACnet/IP network:
 - .1 ;
 - .2 .

- .10 Provide necessary quantities of NC's to meet project requirements and connect NC's together using a BACnet/IP network. Provide sufficient number of NC's to support number of FEC's.
- .11 Comply with system manufacturer's instructions with regards to maximum number of devices to be connected to a power or control circuit.
- .12 Connect operator interface PC installed on project site to BAS via BACnet/IP.
- .13 Provide and connect FEC's to NC's via BACnet MS/TP.
 - .1 To minimize number of mechanical systems that would be inoperative in event of FEC failure, a maximum of 1 major mechanical system is to be controlled by one FEC. Major mechanical systems are as follows:
 - .1 ;
 - .2 .
 - .2 FEC's for equipment (e.g., VAV boxes, VFD's, etc.) are to be connected to same NC used to control associated equipment/system (i.e., AHU, chiller plant, etc.).
 - .3 Failure of a single controller is not to result in system-wide failure.
- .14 Surface wall mount NC 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 responsibility of controls contractor. Wiring is to be in conduit, and conduit and wiring are to be in accordance with standards and requirements of Electrical Division work Sections. Refer to electrical drawings for locations of branch circuit panelboards with dedicated circuits for controls system applications.
- .15 Extend and connect wiring in conduit from terminal unit box actuators and connect to 15A-1P circuit breakers dedicated for terminal unit box applications, in branch circuit panelboards in adjacent spaces. Wiring is to be in conduit, and conduits and wiring are to be in accordance with standards and requirements of Electrical Division. Refer to electrical drawings for locations of branch circuit panelboards with dedicated circuits for controls system applications. No more than 15 terminal unit box circuits are to be connected to one dedicated circuit breaker.
- .16 Provide 120 volt/24 volt transformers as required for control devices.
- .17 Submit schedule(s) of input/output points to Consultant for review. Directly connect each NC 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.
- .18 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.
- .19 Submit Point Data Input forms to Consultant that Owner will fill out with DDC system supplier's assistance. Input this point data into system.
- .20 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.
- .21 Indicate via number, systems controlled by NC and FEC. Indicate via a Lamacoid label mounted inside panel the identification number of electrical panel supplying power to NC and FEC.
- .22 Meet with Owner and provide required number of hours of field work dedicated to following:
 - .1 developing custom dashboards/graphics;
 - .2 setting up time schedules and optimal start/stop programs;
 - .3 setting up alarms including method for monitoring, annunciating and handling of alarms;
 - .4 setting up trends including establishing and storing trend information for systems as required;
 - .5 ensuring all demand limiting and energy conservation strategies are set up according to Owner's energy plan (if applicable).
- .23 Software provided including software to program operator interface and field level controllers to be licensed to Owner. Provide copy of all software used to Owner.
- .24 Graphics and programs to be property of Owner. Provide backup copies of all programs and graphics. Provide any tool sets required to edit graphics.

3.02 SUPPLY OF ACTUATORS AND CONTROLLERS FOR TERMINAL UNITS

- .1 Supply required 24 volt actuators and controllers for terminal units.
- .2 Deliver actuators and controllers to successful terminal unit manufacturer's factory.
- .3 Coordinate delivery of product with General Contractor and successful terminal unit manufacturer.

3.03 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.

3.04 REDUNDANCY

- .1 Provide equipment to perform redundancy requirements as described in Part 2 of this Section.

3.05 CONTROL WIRING AND COMMUNICATIONS CABLING

- .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 the work specified in this Section;
 - .3 starter interlock wiring.
- .2 Install control wiring in EMT in exposed or concealed, inaccessible locations. ULC plenum rated FT6 cable is acceptable for concealed, accessible locations, neatly harnessed, secured and identified. Unless otherwise specified, final 600 mm (2') connection to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.
- .3 Field devices provided with pig-tail wiring without any integral means of flexible metal raceway attachment are to be enclosed with a suitable means to allow for flexible metal raceway attachment.
- .4 Install parallel to building lines, supported from structural members. Raceway or plenum wiring supported from or anchored to piping, duct supports (raceway only), ceiling suspension system (raceway only), or other electrical conduits is not acceptable.
- .5 Use flexible metal raceway, not in excess of 0.9 m (3') in length, for termination of raceway on vibrating equipment. Support flexible metal raceway at each end.
- .6 Use shielded wiring where recommended by manufacturer and install in accordance with manufacturer's instructions.
- .7 Install communications wiring as continuous lengths with no splices between termination points.
- .8 Provide Ethernet/IP communications wiring and devices (hubs, repeaters, etc.) for dedicated use by BAS.
- .9 Wiring work is to be in accordance with BAS manufacturer's certified wiring schematics and instructions, and wiring standards specified in Electrical Division Specification.
- .10 Provide control wiring for water meters, gas meters, etc., as applicable, and connect to BAS for meter data integration.

3.06 INSTALLATION OF ENCLOSURES

- .1 Provide NEMA rated enclosures, and coordinate enclosure locations with other trades and show in submittals.

3.07 IDENTIFICATION AND LABELLING

- .1 Refer to Section entitled Basic Mechanical Materials and Methods.
- .2 Identify BAS equipment as follows:
 - .1 enclosures and other devices mounted in field: engraved laminated nameplates with lettering such as "BAS Panel CP2", or "BAS Relays", or "BAS E/P Transformers", with all wording listed and reviewed with Consultant prior to manufacture of nameplates;
 - .2 panel points: weatherproof input/output layout sheet for each controller with 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: weatherproof 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.

3.08 SOFTWARE SET-UP, CONFIGURATION AND PROGRAMMING

- .1 Provide data base entry, software configuration, initialization of trends and alarms, and custom application programming to meet this specification.
- .2 Set-points, PID tuning parameters, control deadbands, operating differentials, reset schedules, etc. are to be adjustable by an operator without need for accessing/modifying custom control programming code.
- .3 Coordinate number of users, user passwords and user authority profiles with Owner.
- .4 Provide following control software in addition to that described in sequence of operation (where applicable):
 - .1 PID Control: Each control loop is to be controlled by a PID (proportional-integral-derivative) algorithm. Loop is to be tuned using P and I gains as a minimum.
 - .2 Reset: Unless otherwise noted, any set-point required to be reset is to use a cascaded PID loop or an "every x minutes increment/decrement by y" algorithm. Contractor to tune these reset loops to provide stable control.
 - .3 Anti-Short Cycling: AO and DO points are to be protected from short cycling allowing minimum on-time and off-time to be selected. Unless otherwise noted, motors are to be limited to 4 starts per hour (1 per hour for a chiller, 6 for cooling tower fans).
 - .4 Optimum Start: Air handlers that do not operate continuously are to be optimally started at latest possible time to meet occupied conditions at time of occupancy. Utilize space temperature inputs associated with air handler, along with outside air temperature. Algorithm is to include tuning parameters for adjusting influence of space and outside air temperature on start time.

- .1 Warm-up Mode - Optimally started AHU is to operate in warm-up mode until occupancy. Outside air damper(s) close and return air dampers open. If AHU supplies multiple zones (e.g., VAV boxes), supply air temperature is to be space temperature set-point (adjustable).
- .2 Night Setback - When not in occupied or warm-up modes an AHU is to cycle on to maintain a night setback temperature of 15°C (60°F) (adjustable) if AHU supplies a single zone or if zones that cannot provide heating without operation of AHU (pinch-down VAV boxes with reheat coils).
- .5 Alarm Communications: BAS' alarm/event communications features are to be set up to automatically initiate IP-based alarm/event communications (i.e., to pagers, mobile phones, email, alarm printers, etc.) for selected alarms/events. Consult with Owner to determine what communications method(s) is required, communications devices involved, and what alarm conditions/priority/time-of-day are to initiate these communications.
- .6 Demand Limiting/Response:
 - .1 ;
 - .2 .
- .7 Staggered Start:
 - .1 ;
 - .2 .
- .5 Graphic Screens:
 - .1 Provide custom-developed graphic screens for controls included in this project (including points/data specified for digital communication with "3rd party" controls). Screens are to include schematic representations of controlled and/or monitored systems/equipment, points and relevant set-points/parameters (consult with Owner for format and content), and floor plans with space sensing points represented.
 - .2 Prior to creation of graphic screens, meet with Owner to develop, for their approval, a list of screens to be provided, and, for each screen, a conceptual layout of graphics, points/data included, and linkages to other screens. Submit to Consultant for review.
 - .3 Provide operator workstation with a fully programmed operator interface software package. Provide a web-based graphical operator interface. Graphics to be provided as follows:
 - .1 Provide an overall building layout to include overview information related to scheduling and energy consumption of building.
 - .2 Provide floor plans for each floor or area. Operator to be able to switch between various floor plan views as applicable to obtain different information. In all views, floor plans are to provide navigational links to individual control systems. Various floor plans to include:
 - .1 thermal graphics;

- .2 equipment location;
 - .3 lighting (if applicable);
 - .4 energy consumption (if applicable).
- .3 Provide summary plans to permit a quick overview of facility operations. Individual summary plans are to be provided for:
 - .1 thermal comfort;
 - .2 equipment operation;
 - .3 energy consumption.
- .4 Summary plan for thermal comfort is to utilize a 3 light system (green, yellow, red) to provide indication of temperature/humidity control in all areas on one graphic.
- .5 Summary plan for equipment operation (major systems only) to include an indicator of equipment status (on or off) as well as a 3 light system (green, yellow, red) for alarms and an indicator if any system point is overridden.
- .6 Provide individual graphics for each system. Individual graphics to include all I/O points for system, various control carousels as applicable for operator control of system and dynamic animated graphics (moving fans, dampers, etc.). Graphics will also contain links to all associated system for quick access to heating/cooling plants, air handling units, VFD's and/or pumping systems. Individual graphics to also contain energy consumption data where available as well as links to as-built shop drawings, sequences of operation and O&M manuals. All major system graphics will be composed of at least 2 graphics per system. First graphic will provide general information (all I/O, system enable, main set-points and alarms). Second graphic will provide all operator adjustable parameters in table format.
- .6 Point names, schedules, and space temperature set-points are to be chosen to meet approval of Owner (even if specified herein). Submit to Consultant for review.
- .7 Set up logs (including trended points/data, frequency and number of samples) and alarmed points (including alarm limits, alarm messages, alarm message destination email, phone, printer, etc. addresses; and alarm message transmission formats to be used) to meet approval of Owner (consult with Owner and review with Consultant).
 - .1 As a minimum system is to trend all process variables, setpoints, output devices and equipment statuses for each system.
 - .2 Trend intervals (adjustable) are as follows:
 - .1 space temperature/humidity – 15 minutes;
 - .2 duct sensor – 1 minute;
 - .3 pressure sensor – 1 minute;
 - .4 outdoor sensor – 15 minutes;

- .5 actuators – 1 minute;
- .6 binary I/O – on COV;
- .7 setpoints – on COV or with reading as above.
- .8 Only one NC's BACnet BBMD (broadcast messaging management) capability is to be enabled per IP subnet and configured with list of peer BBMD's and its subnet's devices.
- .9 Duct static pressure set points for VAV air handling units are to be selected based on coordination with TAB agency to provide design air flows.
- .10 Coordinate duct differential pressure high/low limit setting values with TAB agency.
- .11 Pipe static pressure set points for variable pumping systems are to be initially selected based on scheduled pressure drop(s) of coils at which static pressure sensor(s) is installed. Final selection is to be based on coordination with TAB agency to provide design water flows.

3.09 DATA CONTROL (D/C) AND GRAPHICS SUMMARY

- .1 Provide hardware, custom software, application software, graphics, etc., necessary to accomplish control sequences and display graphics specified. Provide controllers, inputs, outputs, valves, dampers, actuators and flow meters required to provide control and graphic data described. Provide software set-points required for display in logical groups and graphics.
- .2 Each digital output is to have a software-associated monitored input. Any time monitored input does not track its associated command output within a programmable time interval, a "command failed" alarm is to be reported.
- .3 Where calculated points (such as CFM) are shown, they are to appear in their respective logical groups.
- .4 Unless otherwise specified or approved prior to bidding, primary analogue input and analogue output of each DDC loop is to be resident in a single remote panel containing DDC algorithm, and are to function independent of any primary or UC communication links. Secondary (reset type) analogue inputs may be received from primary network, but approved default values and/or procedures are to be substituted in DDC algorithm for this secondary input if network communications fail or if secondary input becomes erroneous or invalid.
- .5 In addition to unitary DDC controller data points specified to be presented on colour graphic displays, technical data for each zone mechanical apparatus is to be presented to operators on operator workstation in full English menu text displays including:
 - .1 apparatus name;
 - .2 heating and cooling PID loop P, I and D gains;
 - .3 primary CFM airflow (if measured);
 - .4 damper position (% open);
 - .5 reheat status/value;

- .6 cooling set-point;
 - .7 heating dead-band;
 - .8 minimum and maximum CFM set-points;
 - .9 reheat CFM set-point;
 - .10 unoccupied temperature set-point;
 - .11 temperature sensor calibration offset;
 - .12 bypass push button time, in minutes;
 - .13 smoke purge mode damper position;
 - .14 smoke pressurization mode damper position;
 - .15 smoke depressurization mode damper position;
 - .16 morning warm-up mode damper position.
- .6 Such points are to be presented in complete and direct read-write (command) format, unless they are provided in commandable colour graphic displays.
- .7 Following additional graphics are to be provided:
- .1 facility layout (showing buildings, streets, etc.);
 - .2 individual area layouts or isometrics;
 - .3 any other graphics necessary for logical penetration;
 - .4 individual HVAC systems graphics;
 - .5 facility/area layouts including alarm icon indicating which room has alarm;
 - .6 alarms displayed in alarm console linked to facility/area layout graphics to show where on layout alarm has occurred;
 - .7 sequences of operation;
 - .8 supervisor graphics;
 - .9 system configuration.
- .8 Graphic templates of each system and graphics page to be reviewed by Consultant and approved by Owner, prior to installation and start-up.

3.10 APPLICATION REQUIREMENTS

- .1 Software - Microprocessor-based control system is to rely on software for non-critical interlocks and time delays. Where required by specifications, these functions are to be provided by separate thermostats, relays, and delay timers.

- .2 Interlocks - Safety and other interlocks may require relays depending on specific devices being used. Some devices may require a special power supply as shown in wiring details. Safeties are to be hardwired into control circuit and also monitored by BAS.
- .3 Sensors - Select duct insertion sensors to suit application. For large ducts, use sensors with longer probe lengths. For heating and cooling coil freeze protection, use a long capillary type sensor. For mixed air and coil discharge temperature sensing, use averaging capillary type sensors.
- .4 Valves - Ensure actuators meet job requirements (i.e., control signal, close off, action, etc.). Control valves are to be selected to suit both medium and specified configuration (i.e., straight-thru, 3-way, screwed, flanged, etc.).
- .5 Damper Actuators - Total number of actuators may vary depending on damper size. Consult actuator's application literature to determine sizing requirements and use no less than 30% of minimum number of actuators recommended.
- .6 Graphics - System graphics are to include operator control panels to facilitate working with AHUs such as:
 - .1 Warm-up Panel is to permit operator to monitor status of warm-up mode (on or off), and to change set-point of warm-up temperature.
 - .2 Unoccupied Cycle control panel is to permit operator to monitor status of mode (occupied or unoccupied), and to change unoccupied periods set-points.
 - .3 Mixed Air Dampers control panel is to permit operator to monitor economizer mode (on or off), monitor damper position, and to change minimum position set-point.
 - .4 Optimum Start/Stop control panel is to permit operator to monitor and change optimum start/stop program parameters.
 - .5 Reset Schedule control panel is to permit operator to monitor and change reset schedule program parameters. It is not acceptable to monitor and change these modes of control in a manner other than that specified. Having to edit, compile and reload application programs to achieve monitoring and control of these modes is not acceptable.
 - .6 Provide text of control sequence so it may be displayed on operator screen by clicking on sequence control button on system graphic. Sequence will incorporate parameter values and set-points, and will update them dynamically as they change or are changed.

3.11 SYSTEM PERFORMANCE REQUIREMENTS

- .1 Installed system is to conform to following minimum performance standards:
 - .1 Graphic with 20 dynamic points is to display current data within 10 seconds.
 - .2 Graphic with 20 dynamic points is to refresh every 15 seconds.
 - .3 Screens for tuning are to refresh every 6 seconds.
 - .4 Commands from operator interface to device are to take no longer than 5 seconds.

- .5 Alarms are to annunciate at workstation within 45 seconds.
- .6 Field level controllers are to execute PID loops at a response time suitable for application with capability of executing once per second.
- .7 Loop stability:
 - .1 Space temperature to be maintained within $\pm 1^{\circ}\text{C}$ of set-point.
 - .2 Return air humidity to be maintained within $\pm 5\%$ RH of set-point.
 - .3 Duct pressure to be maintained within ± 50 Pa of set-point.
 - .4 Fluid differential pressure to be maintained within ± 250 Pa of set-point.
 - .5 Air volume to be maintained within $\pm 10\%$ of set-point.

3.12 SEQUENCES OF OPERATION AND BAS POINTS

- .1 Refer to mechanical drawings for control diagrams and sequences.
- .2 Points – Points as shown on mechanical drawings are to be considered minimum. Provide points and point types required to meet sequence of operation.
- .3 DDC Sequence for Manually Started Equipment – Unless noted otherwise, when an operator starts main component (e.g., fan, boiler, chiller, etc.) of an HVAC system (e.g., AHU, hot water plant, chiller plant, etc.) by a manual method outside of BAS (e.g., a motor starter H-O-A), BAS will execute described system (based on sensing motor operation via status input).
- .4 Safeties – Safety sequences for high or low temperature reactions are not to be implemented by "software interlocks". Automatic resets of safeties will not be accepted.

3.13 SYSTEM TESTING AND ACCEPTANCE

- .1 Perform BAS acceptance testing in presence of Owner or Owner-designated representative. System is to not be considered substantially complete until testing is complete and accepted. Perform calibration, start-up and testing procedures necessary to assure completion of system acceptance testing prior to commencement of system acceptance tests.
- .2 Point Tests
 - .1 Perform following tests for each point:
 - .1 Analog Input - Compare sensor reading to that of a calibrated portable measurement device.
 - .2 Binary Input - Manually actuate monitored equipment and compare actual state with that read by system.
 - .3 Analog Output - Through software, set output to 3 or more values across full range of actuation and compare with position of controlled device (or output signal for controlled device positions that cannot be visually observed).

- .4 Binary Output - Through software, actuate output and compare control command with actual operation of controlled device.
 - .5 Data (from digital communications with "3rd party controls") - Perform above tests, though comparison (except for data representing binary outputs) between that provided at 3rd party controller display and BAS. Perform above "Binary Output" test for data that represents digital outputs.
- .3 System Tests
- .1 Perform following tests for sequences of operation:
 - .1 Demonstrate DDC loop response. Contractor is to supply trend data output in a graphical form showing step response of each DDC loop. Test is to show loop's response to a change in set-point, which represents a change of actuator position of at least 25% of its full range. Sampling rate of trend is to be from 10 seconds to 3 minutes, depending on speed of loop. For each sample, trend data is to show set-point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control is to require further tuning by Contractor.
 - .2 Simulate loop (i.e. change set-points) to verify reset schedules and temperature lockouts.
 - .3 Manually initiate system start-ups to verify interlocks and sequencing.
 - .4 Simulate safety device and fire alarm system contact actuation to verify emergency, alarm, and life safety sequences.
 - .5 Simulate day/night changeover to observe occupied, unoccupied, optimum start, and warm-up modes.
 - .6 Simulate seasonal changeovers to observe proper operation of heating and cooling modes.
 - .4 In addition, arrange for control system manufacturer to supply at site, qualified control system technicians to make adjustments to control systems to suit air and water balancing and testing.

3.14 CERTIFICATION, START-UP AND TRAINING

- .1 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .2 Refer to Section entitled Basic Mechanical Materials and Methods 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 all BAS functions and features with instruction regarding chronological flow of information from field devices, contacts and sensors to the 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, 8 hour, day to provide additional system training and troubleshooting as required.

3.15 PROJECT CLOSEOUT WORK

- .1 Include following in as-built record drawings at a minimum:
 - .1 schematic outline of BAS for quick reference of overall system scope;
 - .2 adequate record of Work as installed, including its exact location and wiring and route;
- .2 Include following in O&M manual at a minimum:
 - .1 as-built versions of manufacturer's product data with list of equipment supplied, including its make, model number, name of local suppliers and quantity;
 - .2 complete network architecture indicating all network addresses, communication protocols, controllers, controller locations, and equipment controller by each controller;
 - .3 completed BAS test forms/checklists.

3.16 CONTROLS CONTRACTOR'S RESPONSIBILITIES

- .1 Comply with applicable responsibilities specified in this Section and below:
 - .1 provide and pull power wire to controllers;
 - .2 provide start-up, test procedures and O&M manual;
 - .3 provide print out and electronic copy of all points connected to BAS;
 - .4 provide detailed consolidated wiring diagram showing interface of BAS controls with packaged controls;

- .5 responsible for component and point to point testing;
- .6 responsible for sensor calibration and actuator adjustment;
- .7 provide calibration procedure for each analogue sensor;
- .8 operate systems during testing;
- .9 provide training and instruction;
- .10 responsible for acceptance test for a 21 day period;
- .11 set-up trend logs and group logs which are to be stored on hard disk;
- .12 re-visit site during first year of operation to review BAS performance as detailed in this Section in article entitled Certification, Start-Up and Training;
- .13 any other controls requirements specified in Contract Documents.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 Air Movement and Control Association International (AMCA):
 - .1 AMCA Publication 511-[21], Certified Ratings Program - Product Rating Manual for Air Control Devices.
- .2 American Conference of Governmental Industrial Hygienists (ACGIH):
 - .1 ACGIH Industrial Ventilation: A Manual of Recommended Practice for Design, [31st Edition, 2022].
- .3 American National Standards Institute/American Society of Safety Professionals (ANSI/ASSP):
 - .1 ANSI/ASSP Z9.5-[2022], Laboratory Ventilation.
- .4 American National Standards Institute/The Instrumentation, Systems and Automation Society (ANSI/ISA):
 - .1 ANSI/ISA-5.4-[1991], Instrument Loop Diagrams.
 - .2 ISA-TR63082-1 (TR108.1)-[2020], Intelligent Device Management - Part 1: Concepts and Terminology.
 - .3 ANSI/ISA-100.11a-[2011], Wireless Systems for Industrial Automation: Process Control and Related Applications.
 - .4 ANSI/ISA-75, Control Valves (Series of 25 separate standards).
 - .5 ANSI/ISA-96, Valve Actuators (Series of 14 separate standards)..
- .5 CSA Group (CSA):
 - .1 CSA C22.2 No. 24-[21], Temperature-Indicating and -Regulating Equipment.
 - .2 CAN/CSA-C22.2 No. 61010-1-[12(R2022)], Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements (Tri-national Standard, with UL 61010-1 and ANSI/ISA-61010-1 (82.02.01).
- .6 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S538-[2020], Standard for Single and Multiple Station Carbon Monoxide Alarms for Non-Residential Applications.
- .7 Underwriters Laboratories (UL):
 - .1 ANSI/UL 2017-[2018], Standard for General-Purpose Signaling Devices and Systems.
 - .2 ANSI/UL 2034-[2023], Standard for Single and Multiple Station Carbon Monoxide Alarms.
 - .3 UL 60730-2-9-[2022], Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls.

1.02 SUBMITTALS

- .1 Submit in accordance with Section 25 05 01 - Common Work Results for Integrated Building Management Systems.
- .2 Product Data:

- .1 Submit manufacturer printed product literature, specifications and datasheets.
- .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include:
 - .1 Control system components divided in:
 - .1 End Devices (sensors, transmitters, actuators, switches, and similar devices).
 - .2 Equipment and Field Controllers (chillers, AHUs, controllers and similar devices).
 - .3 Building Level Network Controllers (HVAC, Lighting, Security, Metering and similar equipment).
 - .2 Identified schematic control diagrams with component identification, catalogue numbers, and sequence of operation for all controllers.
 - .3 Certified wiring diagrams for systems.
- .4 Submit samples where noted, each identified as to intended use.
- .5 Submit site inspection and start-up report from manufacturer representative.
- .6 Submit testing and verification reports.

1.03 QUALITY ASSURANCE

- .1 Installation of Controls: By control component manufacturer or by licensed personnel authorized by control component manufacturer. Submit written confirmation from control component manufacturer.
- .2 Installation of Equipment Standalone Controls: By equipment manufacturer or by licensed personnel authorized by equipment component manufacturer. Submit written confirmation from control component manufacturer.
- .3 Control Wiring Work: Performed by licensed journeyman electricians, or under direct daily supervision of journeyman electricians.

2. Products

2.01 GENERAL

- .1 Refer to drawings and schedules for additional requirements.
- .2 Major Equipment and System Manufacturers (heat pump, split units exhaust fans): Provide local/field standalone controllers and instrumentation, factory wired internal instrumentation or shipped loose for remote instrumentation installation.
- .3 Include mounting and connection accessories, suiting intended mounting locations, and intended applications.
- .4 Physical interconnections of instruments and devices interconnected to form loops to be in accordance with ANSI/ISA-5.4.
- .5 Intelligent device management concepts and terminology: In accordance with ISA-TR63082-1 (TR108.1).

- .6 Wireless systems to provide reliable and secure wireless operation for non-critical monitoring, alerting, supervisory control, open loop control, and closed loop control applications: In accordance with ANSI/ISA-100.11a.
- .7 Temperature sensing controls: In accordance with UL 60730-2-9.

2.02 LOCAL CONTROL PANELS

- .1 Wall-mounting, enamelled steel barriered enclosures, sized suiting intended application with 20% spare capacity, unless otherwise noted.
- .2 Perforated sub-panel, numbered terminal strips for low and line voltage wiring, hinged door, and slotted flush latch.
- .3 NEMA 2 type unless otherwise noted, enclosures in climate-controlled areas, and in sprinklered areas.

2.03 CONTROL SYSTEM COMPONENTS - GENERAL

- .1 Components specified below provide control of equipment and systems in accordance with drawing control diagrams, details, and sequences of operations. Drawing control diagrams and details are schematic and only include major components, identifying intent of design and general performance of systems.
- .2 Provide additional ancillary components, providing complete functional control systems, performing in accordance with specified requirements.
- .3 Control devices of each category are of same type and manufacturer.
- .4 External trim materials are corrosion resistant.
- .5 Outdoor Installations: Provide weatherproof construction in NEMA 4 enclosures, unless otherwise noted.
- .6 Where connected to BMS/BAS: Provide hardware, integrating with Division 25 BMS/BAS, for control and monitoring of input/output points, in accordance with BAS functionality requirements, points schedule, control diagrams and operation sequences. Provide communications interfaces fully compatible with BMS/BAS.
- .7 In accordance with:
 - .1 CSA C22.2 No. 24.
 - .2 ANSI/ISA-96 Series.
- .8 Smart Direct Coupled Actuators:
 - .1 Applications for use in HVAC systems automatically controlled devices, for driving quarter-turn final control elements of volume control dampers, rotary valves, and with linkages providing linear stroke of globe or cage valves.
 - .2 Sized to operate their appropriate loads with sufficient reserve power providing smooth modulating action or two-position action and tight close-off.
 - .3 Provides two-position, floating, analog signal control, or digital smart communication control, as required to match controller output.
 - .4 Power failure return type where valves or dampers are required to fail to safe position and where noted.
 - .5 Brushless DC ball bearing sub-motor, microprocessor controlled by monitoring:
 - .1 Speed.

- .2 Torque.
- .3 Position for stall protection.
- .4 Positional accuracy.
- .6 Direct coupled, mounting to round or square jackshaft, using removable output hub with self-centering shaft adapter that provides concentric mounting with single bolt for tightening, for 95-degree stroke and integral adjustable range-stop mechanism.
- .7 Ratings based on minimum design life torque of: 3 Nm, 5 Nm, 10 Nm or 20 Nm, suiting intended applications.
- .8 Screw terminal wiring connections located within integral access cover, with conduit opening for either standard conduit fittings or water-tight cable strain-relief fittings, NEMA 2 rated or IP54, suiting intended applications.
- .9 Housing provides for flippable installation to reverse spring return direction, providing either clockwise or counter-clockwise fail-safe operation.
- .10 Provides continuously engaged mechanical spring, which returns to fail-safe position in less than 25 seconds.
- .11 Provides immediate positioning upon power-up.
- .12 Timing constant and independent of load and supply voltage, over entire temperature, and voltage ranges.
- .13 Minimum Design Life: 60,000 full stroke cycles, 60,000 spring-return cycles, and 1,500,000 repositions at rated torque and temperature.
- .14 Communications:
 - .1 Two – wire, polarity insensitive bus provides digital and analogue communications between actuator devices and controllers, including:
 - .1 Control command for actuator positions and travel time.
 - .2 Operational feedback:
 - .1 Actual positions.
 - .2 Cycle count.
 - .3 Status.
 - .4 Overridden.
 - .5 Power reports.
 - .2 Microprocessor control provides redundant position feedback methods, feedback potentiometer and counting motor commutations, for accurate position tracking.
- .15 Proportional or Floating Control:
 - .1 Proportional Control: Direct acceptance of 2 VDC to 10 VDC or 4 mA to 20 mA input signal from controllers.
 - .2 Floating Control: Direct acceptance of 24 VAC pulse-width modulated open and close commands from tri-state controller.
 - .3 Rotation direction control switch accessible on cover to change between proportional or floating control.
 - .4 High input impedance (95 K Ω minimum) allowing common control signal to drive multiple actuators.
 - .5 Input signal filtering exceeding standard requirements for protection against Radio Frequency Interference (RFI) and Electro-Magnetic Interference (EMI).

- .6 Microprocessor control monitors duration of floating control input signal and driving, in response to duration of signal, for accurate positioning.
- .7 Microprocessor control provides redundant position feedback methods, feedback potentiometer and counting motor commutations, for accurate position tracking.
- .16 Two-Positions:
 - .1 Two-position Control: Direct acceptance of 24 VAC / VDC or 100 VAC to 250 VAC power controlled by SPST switch.
 - .2 Double-insulated line-voltage circuits, and no ground required.
- .9 Spring Return Direct Coupled Actuators:
 - .1 Direct coupled type for mounting to jackshaft of up to 20 mm diameter, without use of crankarm or linkage.
 - .2 Can drive variety of quarter-turn, final control elements requiring spring return fail-safe operation.
 - .3 Types (suited intended applications):
 - .1 2-position.
 - .2 Modulating Control:
 - .1 Electronic rotary fail-in-place.
 - .2 Electronic-fail-safe.
 - .4 Brushless DC sub-motor with electronic stall protection.
 - .5 Connects to shaft using removable output hub with self-centering shaft coupling that provides concentric mounting and includes integral adjustable range-stop mechanism.
 - .6 Actuator provides floating and proportional control to direct acceptance of 0 to 10 VDC, 2 to 10 VDC, or 4 mA to 20 mA input signal.
 - .7 Some proportional and floating control types provide feedback signal, suited intended applications.
 - .8 Floating actuators include rotation direction control switch accessible on cover.
 - .9 Designed for either clockwise or counter-clockwise fail-safe operation with continuously engaged mechanical spring that returns valve or actuator to fail-safe position within 25 seconds of power loss.
 - .10 Designed for minimum of 60,000 full-stroke cycles at rated torque and temperature, 60,000 spring return cycles and 1,500,000 repositions.
 - .11 Run time constant and independent of load, temperature, and supply voltage.
 - .12 Sized to tightly shut control valves against differentials imposed by system.
 - .13 Position indicators.
- .10 Non-spring Return Control Valve Actuators:
 - .1 Non-spring return, fail in place, control of ball valves to control hot and chilled water with glycol solutions up to 50%.
 - .2 Floating and modulating control.
 - .3 Plenum rated plastic housing.
 - .4 Click on installation.
 - .5 Extendable position indicator for easy commissioning.
 - .6 Design Life (at Rated Voltage): 60,000 cycles.
 - .7 Can be mounted on valve in any of four positions.

- .11 Electric Valve Operators:
 - .1 Rotary Types: Unless otherwise noted, typically used with ball, plug, and butterfly valves that rotate quarter-turn or more from open to close.
 - .2 Linear Types: Unless otherwise noted, typically used with gate, globe, diaphragm, pinch, and angle valves that feature sliding stem that opens or closes valve.
 - .3 Enclosed reversible gear type operators that accept modulating control signals.
 - .4 AC motor providing high torque from standstill and includes sensors identifying when end position reached and torque switching measures torque present in valve.
 - .5 Operational controls.
 - .6 One phase AC, 120 V or 24 V suiting intended applications, as noted.
 - .7 Thermal overload protected.
 - .8 Manual overrides.
 - .9 Position indicators.
 - .10 Enclosure of NEMA ratings suiting mounting location.

2.04 CONTROL DAMPERS AND OPERATORS

- .1 General Features:
 - .1 AMCA Publication 511 certified low leakage aluminium dampers.
 - .2 100 mm deep, flanged.
 - .3 Dampers for modulating and mixing applications: Opposed blade type.
 - .4 Dampers for Open-shut Service: Parallel blade type.
 - .5 Maximum Blade Length: 1 m.
 - .6 Dampers Greater than 2 sections Wide: With jackshaft.
 - .7 Extruded 6063T5 aluminum frame and airfoil blades, each with integral slot to receive a gasket.
 - .8 Extruded TPE frame gaskets and extruded EPDM blade gaskets.
 - .9 Steel Linkage:
 - .1 Slip-proof aluminium and corrosion resistant plated.
 - .2 Metal thickness preventing warping or bending during damper operation.
 - .3 Concealed in frame.
 - .4 Equipped with self-sealing and self-lubricating bearings consisting of acetal copolymer inner bearing fixed on hexagonal blade pin and rotating in polycarbonate outer bearing inserted in frame.
- .2 Outdoor Air Intake and Exhaust Air Applications: Insulated dampers with features as above but with all four sides of frame insulated with polystyrene, and blades thermally broken and insulated with expanded polyurethane foam.
- .3 Applications where ductwork is other than galvanized steel: Stainless steel dampers, as above but constructed of type 316 stainless steel and equipped with Teflon blade bearings.
- .4 Damper Operators and Motors:
 - .1 24 V or 120 VAC, suiting intended applications and as noted.
 - .2 Direct coupled electric motor operators for either modulating or two position control, suiting intended applications.

- .3 Spring return or non-spring return, fail safe in normally open or normally closed position, suiting intended applications.
- .4 Sized to control damper against maximum pressure or dynamic closing pressure, whichever is greater, suiting sizes of dampers involved, and providing sufficient force maintaining damper rated leakage characteristics.
- .5 Damper position indicator, and external adjustable stops limiting length of stroke in either direction or mounted on corrosion-resistant adjustable bracket.
- .6 Operating arms include double yoke linkages and double set screws for fastening to damper shaft.
- .7 Operators for dampers connected to building fire alarm system or to freeze protection devices: Provide additional relays, permitting dampers to respond and go to required position in less than 15 seconds upon receipt of a signal.
- .8 Operator enclosures are to be suitable in all respects for environment in which they are located.

2.05 SENSOR AND TRANSMITTER INPUT DEVICES

- .1 Types suiting intended applications and mounting locations.
- .2 Do not provide sensors using pneumatic signals for sensing temperature.
- .3 Resistance Type Temperature Sensors:
 - .1 Two-wire 1000 ohm nickel RTD.
 - .2 Two-wire 1000 ohm platinum RTD.
 - .3 Accuracy (includes errors associated with sensor, lead wire, and A to D conversion), equipped with type 316 stainless steel thermowells for pipe mounting applications:
 - .1 Chilled water, room temperature, and duct temperature points: $\pm 1^{\circ}\text{C}$.
 - .2 Other points: $\pm 0.75^{\circ}\text{C}$.
- .4 Room Temperature Sensors:
 - .1 Surface or recessed wall box mounting.
 - .2 Adjustable set-point reset slide switch with $\pm 1.66^{\circ}\text{C}$ range.
 - .3 Individual heating/cooling set-point slide switches, momentary override request pushbutton for activation of after-hours operation, and analogue thermometer.
 - .4 Where local display is noted, include LCD display with sensor for viewing space temperature, setpoint and other operator selectable parameters. User operable buttons adjust setpoints directly from sensor.
- .5 Outside or Non-Climate-Controlled Areas Air Sensors:
 - .1 Suiting ambient temperatures and withstanding environmental conditions to which they are exposed.
 - .2 NEMA 4 type unless otherwise noted, enclosure with solar shield, and perforated plate surrounding sensor element where exposed to wind velocity pressure.
 - .2 Typically, sensing element provided on building north side.
 - .3 Sensing element fully encapsulated in potting material within stainless steel probe.
 - .4 Probe encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
 - .5 Operating Range: Minus 40°C to 50°C .

- .6 Indoor Air Quality (IAQ) Multi-Sensors:
 - .1 Sensors of wall-mounting type, for monitoring temperature, humidity, CO₂, particle matter PM1.0, PM2.5, PM10, and total volatile organic compounds (TVOC).
 - .2 Output via BACnet MS/TP or Modbus RTU.
 - .3 Display of Air Quality Score:
 - .1 Score based on CO₂, PM2.5, and TVOC detected.
 - .2 Individual parameter description / units incorporated into display.
 - .3 Operating Environment: 0°C to 50°C, 0 to 95% RH (No condensation).
 - .4 Input Voltage: 24 VAC/VDC.
 - .5 Sensed Mediums:
 - .1 Temperature Measuring Range: 0 to 50°C, accuracy $\pm 1^{\circ}\text{C}$.
 - .2 Humidity measuring range: 0 to 100%, accuracy $\pm 3\%$ RH (20% to 80% RH).
 - .3 Carbon Dioxide Measuring Range: 0-9999 ppm, accuracy ± 75 ppm @ 400 to 1000 ppm, ± 40 ppm @ 1001 to 2000 ppm.
 - .4 Particulate Matter Measuring Range: 0 to 5000 $\mu\text{g}/\text{m}^3$, accuracy ± 10 $\mu\text{g}/\text{m}^3$, 0 to 100 $\mu\text{g}/\text{m}^3$, 101 to 500 $\mu\text{g}/\text{m}^3$, $\pm 10\%$ reading.
 - .5 Total VOC measuring range: 0 to 9000 ppb, accuracy $\pm 25\%$ reading.
- .7 Insertion Duct Mounting Sensors:
 - .1 With lock nut and mounting plate, designed for mounting in electrical box (weatherproof with gasket and cover where outside or in non-climate-controlled areas), through hole in duct.
 - .2 Sensing element fully encapsulated in potting material within stainless steel probe.
 - .3 Useable in air handling applications where coil or duct area is less than 1.3 m².
- .8 Duct Averaging Type Sensors:
 - .1 With multiple sensing points.
 - .2 For ducts greater than 1.3 m² or for ducts where air temperature stratification occurs.
 - .3 For plenums applications such as mixed air temperature measurement, accounting for air turbulence and/or stratification, averaging string of sensors with capillary supports on sides of duct/plenum.
 - .4 Sensor tube contains at least one thermistor for every 900 mm, with minimum tube length of 1.8 m.
 - .5 Sensor constructed of rigid or flexible copper tubing.
- .9 Humidity Wall Transmitters:
 - .1 Transmitters Accuracy: $\pm 1\%$ at full scale, and with certification of National Institute of Standards and Technology (NIST) calibration.
 - .2 LCD display.
 - .3 Element: Replaceable sensing.
 - .4 Sensor Type: Thin-film capacitive.
 - .5 Sensor Element: Contains multipoint calibration on-board in non-volatile memory.

- .6 Operating Range: 0 to 100% RH noncondensing, 10 to 35 °C.
- .7 Output: Field selectable 4 to 20 mA or 0 to 5 VDC or 0 to 10 VDC, suiting intended applications.
- .8 Accepts 12 to 30 VDC or 24 VAC supply power, suiting intended applications.
- .9 Transmitter enclosure: High impact ABS plastic for mounting on standard electrical box.
- .10 Integrated temperature sensor where noted.
- .10 Humidity Duct Transmitters:
 - .1 Transmitter Accuracy: +/- 1% at full scale, and with certification of National Institute of Standards and Technology (NIST) calibration.
 - .2 Fully encapsulated in potting material within stainless steel probe.
 - .3 Element: Replaceable sensing.
 - .4 Sensor Type: Thin-film capacitive.
 - .5 Sensor Element: Contains multipoint calibration on-board in non-volatile memory.
 - .6 Operating Range: 0 to 100% RH noncondensing, minus 40 to 50°C.
 - .7 Output: Field selectable 4 mA to 20 mA or 0 to 5 VDC or 0 to 10 VDC, suiting intended applications.
 - .8 Accepts 12 to 30 VDC or 24 VAC supply power, suiting intended applications.
 - .9 Integrated temperature sensor where noted.
- .11 Humidity Outdoor Transmitters:
 - .1 Transmitter Accuracy: +/- 2% at full scale, and with certification of National Institute of Standards and Technology (NIST) calibration.
 - .2 Fully encapsulated in potting material within stainless steel probe.
 - .3 Probe encased in PVC solar radiation shield and mounted in weatherproof enclosure.
 - .4 Element: Replaceable sensing.
 - .5 Sensor Type: Thin-film capacitive.
 - .6 Sensor Element: Contains multipoint calibration on-board in non-volatile memory.
 - .7 Operating Range: 0 to 100% RH noncondensing, minus 40 to 50°C.
 - .8 Output: Field selectable 4 to 20 mA or 0 to 5 VDC or 0 to 10 VDC, suiting intended applications.
 - .9 Accepts 12 VDC to 30 VDC or 24 VAC supply power, suiting intended applications.
 - .10 Integrated temperature sensor where noted.
- .12 Carbon Dioxide Wall Transmitters:
 - .1 Sensor Type: Non-dispersive infrared (NDIR).
 - .2 Accuracy: ± 30 ppm $\pm 2\%$ of measured value with annual drift of ± 10 ppm. Minimum five-year recommended calibration interval.
 - .3 Repeatability: ± 20 ppm $\pm 1\%$ of measured value.
 - .4 Response Time: Less than 60 seconds for 90% step change
 - .5 Outputs:
 - .1 Field selectable analog: 4 to 20 mA or 0 to 5 VDC or 0 to 10VDC.
 - .2 Protocol: Modbus or BACnet.
 - .3 SPDT relay 1A@30VDC or temperature setpoint slider.

- .6 Accepts 12 VDC to 30 VDC or 24 VAC supply power, suiting intended applications.
- .7 Temperature Range: 0 to 50°C.
- .8 Output range programmable 0 to 2000 ppm or 0 to 5000 ppm.
- .9 Enclosure:
 - .1 Constructed of high impact ABS plastic with snap-on cover.
 - .2 Mounting on standard electrical box.
- .10 LCD Display:
 - .1 For commissioning.
 - .2 Includes snap-on faceplate.
- .11 Integrated humidity sensor and temperature sensor where noted.
- .13 Carbon Dioxide Duct Transmitters:
 - .1 Sensor Type: Non-dispersive infrared (NDIR).
 - .2 Accuracy: ± 30 ppm $\pm 2\%$ of measured value with annual drift of ± 10 ppm. Minimum five-year recommended calibration interval.
 - .3 Repeatability: ± 20 ppm $\pm 1\%$ of measured value.
 - .4 Response Time: Less than 60 seconds for 90% step change.
 - .5 Outputs:
 - .1 Field Selectable Analog: 4 to 20 mA or 0 to 5 VDC or 0 to 10VDC.
 - .2 Protocol: Modbus or BACnet.
 - .3 SPDT relay 1A@30VDC or temperature setpoint slider.
 - .6 Accepts 12 VDC to 30 VDC or 24 VAC supply power, suiting intended applications.
 - .7 Temperature Range: 0 to 50°C.
 - .8 Output range programmable 0 to 2000 ppm or 0 to 5000 ppm.
 - .9 Enclosure:
 - .1 Constructed of high impact ABS plastic with snap-on cover.
 - .2 Not require remote pickup tubes.
 - .3 Not make use of integrated H-beam probe to channel air flow to sensor.
 - .10 LCD Display: For commissioning.
 - .11 Integrated humidity sensor and temperature sensor where noted.

2.06 PRESSURE TRANSMITTERS

- .1 General:
 - .1 Withstand 100% pressure over-range without damage and holds calibrated accuracy when subject to momentary 40% over-range input.
 - .2 Certification of National Institute of Standards and Technology (NIST) calibration.
 - .3 Output: Field selectable 4 mA to 20 mA or 0 to 5 VDC or 0 to 10 VDC, suiting intended applications.
 - .4 Accepts 12 VDC to 30 VDC or 24 VAC supply power, suiting intended applications.
 - .5 Air Pressure Transmitters:
 - .1 Sensor: Microprocessor profiled ceramic capacitive sensing element.
 - .2 Range:

- .1 14 selectable ranges from 0.25 kPA to 2.5 kPA.
 - .2 Field selectable for PA or WC.
 - .3 Accuracy: +/- 1% accurate in each selected range including linearity, repeatability, hysteresis, stability, and temperature compensation.
 - .4 Field configurable to mount on wall or duct with static probe.
 - .5 Field selectable for unidirectional or bidirectional.
 - .6 Maximum Operating Pressure: 200% of design pressure.
 - .7 Response Time: Field selectable T95 in 20 sec or T95 in 2 sec.
 - .8 LCD display.
 - .9 Zeroing by pushbutton or digital input.
- .6 Liquid Differential Pressure Transmitters:
 - .1 Microprocessor based, using two independent gauge pressure sensors to measure and calculate differential pressure.
 - .2 Four switch selectable ranges.
 - .3 Test mode to produce full-scale output automatically.
 - .4 Zeroing by pushbutton or digital input.
 - .5 Field selectable electronic surge damping.
 - .6 Electronic port swap feature.
 - .7 Sensor: 17-4 PH stainless steel where it contacts working fluid.
 - .8 Accuracy: $\pm 1\%$ full scale. and $\pm 2\%$ full scale for lowest selectable range
 - .9 Long Term Stability: $\pm 0.25\%$.
 - .10 Sensor Temperature Operating Range: Minus 20°C to 10°C.
 - .11 Operating Environment: Minus 10°C to 55°C; 10% to 90% RH noncondensing.
 - .12 Proof Pressure: Two times maximum full-scale range.
 - .13 Burst Pressure: Five times maximum full-scale range.
 - .14 Encased in NEMA 4 enclosure of white powder-coated aluminum construction.
- .2 Differential Pressure Transmitters:
 - .1 Flow measurement sized to flow sensing device and supplied with tee fitting and shut-off valves in high and low sensing pick-up lines, allowing permanent ease of use connection for balancing, and other functions.
 - .2 Transmitter housing of type suiting mounting location, fire-retardant and corrosion resistant.
 - .3 Standalone pressure transmitters mounted in NEMA 2 rated, by-pass valve assembly panel with high and low connections piped and valved, air bleed units, by-pass valves, and compression fittings.
- .3 Building differential air pressure transmitters:
 - .1 Industrial quality transmitter with range, suiting intended applications.
 - .2 Transmits linear 4 mA to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - .3 With non-interactive zero and span adjustments adjustable from outside cover.
 - .4 Performance as follows:
 - .1 Maintain Accuracy: Up to 20 to one ratio turndown.

- .2 Reference Accuracy: +0.2% of full span.
- .4 Low Differential Air Pressure Transmitters, 0 kPa to 1.25 kPa:
 - .1 Industrial quality transmitter with range suiting intended applications.
 - .2 Transmits linear 4 mA to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - .3 With non-interactive zero and span adjustments adjustable from outside cover.
 - .4 Performance as follows:
 - .1 Maintain Accuracy: Up to 20 to one ratio turndown.
 - .2 Reference Accuracy: +0.2% of full span.
- .5 Medium Differential Air Pressure, over 1.5 kPa:
 - .1 Industrial quality transmitter with range suiting intended applications.
 - .2 Transmits linear 4 mA to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - .3 Combined non-linearity, repeatability, and hysteresis effects: Not to exceed $\pm 0.5\%$ of full-scale output over entire range.
 - .4 Output Variations: Less than 0.2% full scale for supply voltage variations of $\pm 10\%$.
 - .5 Integral zero and span adjustment.
 - .6 Thermal Effects: Not to exceed $\pm 1.5\%$ full scale/ 50 C°.
 - .7 Over-pressure input protection to at least twice rated input pressure.
 - .8 Output short circuit and open circuit protection.
 - .1 power supply.
- .6 Duct Mounting Smoke Detectors:
 - .1 Coordinate with and provide as part of work of Division 28 fire alarm system work.
 - .2 For mounting and integration with control system work.

2.07 GAS DETECTION SYSTEMS

- .1 Microprocessor-based gas detection system, programmable monitoring, and alarm equipment, in accordance with:
 - .1 CAN/CSA-C22.2 No.UL 61010-1.
 - .1 CAN/ULC-S538.
 - .2 ANSI/UL 2017.
 - .3 ANSI/UL 2034.
- .2 Control Panel:
 - .1 24 VAC, wall-mounting panel of type NEMA 4 unless otherwise noted, enclosure.
 - .2 Communicating digitally with networked transmitters and relay modules through digital communication buses, each capable of accepting combination of multiple addressable transmitters, relay modules, or annunciator panels at a maximum distance of 600 m, with power supply sufficient to power entire gas detection network.
 - .3 Factory programmed software, enabling sequence of operation.

- .4 Internal DPDT relays rated suiting intended applications, at fully programmable alarm levels and within programmable time delays and activating multiple relay modules of external relays each at programmable alarm set-points and time delays.
- .5 Alphanumeric display indicating concentration and type of gas detected as well as location of sensor/transmitter, and two alarm levels for each sensing point.
- .6 Identified LEDs indicating Power, Alarm Levels A, B and C, and/or Fault.
- .7 Audible alarm rated at minimum 65 dBA at 1 m that fully activates at programmable levels.
- .8 Three levels of continuous diagnostics, verifying reading of each sensor/transmitter for abnormal sensing behaviour, loss of communication between control panel and sensor/transmitter, and program corruption analysis.
- .9 Capability of long-term data logging to determine trends.
- .10 Communicating with BMS/BAS:
 - .1 Monitoring exhaust fan status (primary or secondary), zone concentration and alarms through required protocol.
 - .2 For monitoring system status and viewing logged historical data.
 - .3 Communication interface protocol compatible with BMS/BAS.
- .3 Carbon Monoxide Sensor/Transmitter:
 - .1 Wall-mounting 24 VAC sensor.
 - .2 NEMA 4 type unless otherwise noted, enclosure with protective cover-plate that does not restrict sensor operation.
 - .3 Microprocessor-based, factory calibrated, ambient humidity and temperature compensated CO element capable of producing digital serial loop output signal to control panel.
 - .4 Alphanumeric LCD display indicating system status and gas concentration level and identified LEDs, indicating Power (green), and Alarm Levels A and B (amber).
 - .5 Audible alarm rated at minimum 65 dBA at 1 m, that fully activates at programmable levels.

2.08 STANDALONE CO AND NO₂ SENSORS

- .1 Standalone sensors with features as follows:
 - .1 24 V AC/DC wall-mounting units.
 - .2 Factory programmed software, enabling required sequence of operation.
 - .3 Internal DPDT relays rated suiting intended applications, at fully programmable alarm levels and within programmable time delays and activates remote devices such as fan starters.
 - .4 Alphanumeric display indicating exact concentration and type of gas detected, and two alarm levels for each sensing point.
 - .5 Identified LEDs, indicating Power (green), and Alarm Levels A and B (amber).
 - .6 Audible alarm rated at minimum 65 dBA at 1 m, that fully activate at programmable levels.
 - .7 Continuous monitoring electro-chemical sensors, one for carbon monoxide, one for nitrogen dioxide.
 - .8 Communicating with BMS/BAS, monitoring exhaust fan status (primary or secondary), zone concentration and alarms through required protocol.

2.09 DIGITAL TO ANALOG OUTPUT CONVERTORS

- .1 24 VAC convertors, communicating digitally with multiple sensor/transmitter units and control panel within daisy-chain network.
- .2 Converting digital signal from transmitters to analog outputs, permitting each transmitter to produce dedicated 4 mA to 20 mA signals to BMS/BAS or variable frequency drive, suiting intended applications, from one central location at maximum of 600 m from control panel.

2.10 SWITCHES, RELAYS AND TRANSDUCERS

- .1 Double Contact Switches: Monitoring equipment status and safety conditions and generate alarms when failure or abnormal condition occurs.
- .2 Status and Safety Switches:
 - .1 Current Sensing Switches: Self-powered dry contact output switches for sensing run status of motor loads, each calibrated indicating positive run status only when motor is operating under load, and each consisting of current transformer, solid-state current sensing circuit, adjustable trip point, solid-state switch, SPDT relay, and LED indicating ON or OFF status.
 - .2 Air Filter Status Switches: Automatic reset type differential pressure switches, each with SPDT contacts rated suiting intended applications, scale range and differential pressure adjustment appropriate for service, and installation kit which includes static pressure taps, tubing, fittings, and air filters.
 - .3 Air Flow Switches: Pressure flow switches, bellows actuated mercury switch or snap-acting micro-switch type, suiting intended applications, with appropriate scale range and pressure adjustment.
 - .4 Air Pressure Safety Switches: Manual reset switches, each with SPDT contacts rated suiting intended applications and with appropriate scale range and pressure adjustment.
 - .5 Water Flow Switches: Adjustable differential pressure switches detect flow suiting intended applications. Switches incorporate two opposing pressure elements and adjustable range setpoint spring with calibrated scale. Switches at indicated setpoint on increase in differential pressure and switches back to normal position when different pressure decreases to setpoint less mechanical switching differential.
 - .6 Low Temperature Limit Switches: Manual reset type, each with DPST snap acting contacts rated suiting intended applications, minimum 4.5 m sensing element for mounting horizontally across duct/plenum with sensing reaction from coldest 450 mm section of element, and where sensing element does not provide full coverage of air stream, additional switches, as required.
 - .7 Tank Level Switches: Indicate high/low water level and to alarm. For mounting on top of tank. Snap action contacts and adjustable setpoint and differential.
 - .8 Sump Level Switches: Liquid level activated switch sealed in waterproof and shockproof enclosure. With float, flexible cord, weight, instrument casing suitable for immersion in measured liquid and N.O. and N.C. contacts.
- .3 Control Relays:
 - .1 Control Pilot Relays: Modular plug-in design with snap-mount mounting bases, retaining springs or clips, DPDT, 3 PDT or 4 PDT suiting intended applications, and with contacts rated suiting intended applications.

- .2 Lighting Control Relays: Latching type with integral status contacts rated suiting intended applications, each with split low voltage coil that moves voltage contact armature to ON or OFF latched position, each controlled by pulsed tri-state output (preferred) or pulsed paired binary outputs, and each designed so power outages do not result in change-of-state and so multiple same state commands maintain commanded state.
- .4 Current Sensing Relays:
 - .1 Suitable to detect belt loss or motor failure.
 - .2 Trip point adjustment, output status LED.
 - .3 Relay contacts rated for intended applications.
 - .4 Suitable for single or three phase monitoring.
- .5 Electronic Signal Isolation Transducers:
 - .1 Installed whenever analog output signal from EMCS/BAS is connected to external control system as input (such as equipment control panel) or receives input signal from remote system.
 - .2 Provides ground plane isolation between systems.
- .6 Electronic/Pneumatic Transducers:
 - .1 Output from 20 kPa to 100 kPa, input from 4 mA to 20 mA or 10 VDC.
 - .2 Manual output adjustment, pressure gauge, and external replaceable supply air filter.

2.11 MANUAL OVERRIDE STATIONS

- .1 Each manual override station includes contacts rated suiting intended applications (minimum 1 ampere at 24 VAC) and provides following:
 - .1 Integral H-O-A switch to override controlled device pilot relay.
 - .2 Status input to EMCS/BAS, indicating whenever switch is not in Auto position.
 - .3 Status LED illuminates whenever output is On.
 - .4 Override LED illuminates whenever H-O-A switch is in either Hand or Off position.

2.12 STANDARD THERMOSTATS

- .1 Wall-mounting adjustable set-point thermostats, each suiting intended applications for equipment (and operating sequence) they are provided for, equipped with thermometer, cover and mounting and connection accessories.
- .2 Thermostats: 115 V line voltage or 24 V electronic type thermostats, suiting intended applications.
- .3 Set-point Adjustment for Thermostats:
 - .1 In public spaces are concealed behind cover.
 - .2 Other thermostats, accessible through cover.
- .4 Covers are removable, tamperproof with temperature set-point and thermometer displays.
- .5 Guards for thermostats: Clear, ventilated polycarbonate covers with Allen type key locking hardware.

2.13 HUMIDISTATS

- .1 Direct or reverse acting (suitsing system), proportional type, adjustable humidity controllers, each corrosion resistant, suitsing intended applications.
- .2 With nylon element, replaceable cartridge type air filter, internally adjustable limit stops for maximum and minimum settings, cover and mounting and connection accessories.
- .3 Electric Humidistats: 115 V line voltage, or 24 V electronic low voltage types, suitsing intended applications.
- .4 Wall-Mounting Humidistats: With tamper-proof display type cover.
- .5 Duct Mounting Humidistats: With display type cover, duct sampling chamber with 300 mm long extruded pick-up tube for duct mounting, moulded mounting base, and ventilated cover.

2.14 SYSTEM WIRING MATERIALS

- .1 Coordinate provision of system wiring, conduit, boxes, and similar materials, in accordance with requirements of electrical work of Division 26 and control device manufacturer recommendations.

2.15 ACCEPTABLE PRODUCT MANUFACTURERS

3. Execution

3.01 GENERAL - INSTALLATION OF CONTROLS

- .1 Provide systems of control and instrumentation for equipment and systems in accordance with this Section, schedules, and drawings.
- .2 Drawing control diagrams, details, and sequence of operations, generally are schematic and identify typical sequence of operations, and do not necessary include all components.
- .3 Control diagrams show only principal components controlling equipment and systems. Supplement each control system with relays, transformers, sensors, and ancillary devices, enabling each system to perform as specified and permitting proper operation and supervision.
- .4 After commissioning is complete, install equipment and components so that manufacturer and CSA labels are visible and legible.
- .5 Install field control devices in accordance with manufacturer recommended methods, procedures, and instructions.
- .6 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: Install in NEMA 2 enclosure or with greater rating suitsing intended applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
- .7 Install devices in locations readily accessible and adaptable to each type of application, allowing for quick easy viewing, and replacement and servicing without special tools or skills.
- .8 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.

- .9 Firestopping: Provide space for firestopping materials in accordance with Section 23 00 15 - Common Work Results for Mechanical or Section 07 84 10 - Comprehensive Firestopping. Maintain fire-resistance rating integrity of fire separation.

.10 .

3.02 SUPPLY OF CONTROL AIR DAMPERS AND OPERATORS

- .1 Unless otherwise noted, supply 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 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.
- .3 Where sequence operation is noted, or where multiple operators drive a series of dampers, provide pilot positioners to couple their action.
- .4 For dampers located in ductwork other than galvanized steel, provide dampers of type 316 stainless steel construction.
- .5 Provide operator for each valve.

3.03 ACTUATORS, CONTROLLERS, AND TRANSFORMERS

- .1 Coordinate provision of actuators, controllers and transformers for terminal units and other equipment, suiting intended applications.
- .2 Where devices are installed to equipment offsite at equipment manufacturer factory, supply and deliver devices to equipment manufacturer factory, for installation.
- .3 Coordinate delivery of devices.
- .4 Unless otherwise noted and suiting intended applications, provide automatically controlled devices with actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off.
- .5 Actuators provides two-position, floating, analog signal control, or digital smart communication control, as required to match controller output.
- .6 Provide actuators of power failure return type where valves or dampers are required to fail to safe position and where noted.

3.04 INSTALLATION OF CONTROL SYSTEM COMPONENTS

- .1 Provide control system components and related hardware. Refer to drawing control diagrams and sequence of operations.
- .2 Where components are pipe, duct, or equipment mounted, supply components at proper time, coordinate installation with appropriate trade, and provide ancillary installation and mounting components.

3.05 INSTALLATION OF THERMOSTATS

- .1 Provide thermostats of types as noted, suiting intended applications.
- .2 Install in locations readily accessible and adaptable to each type of application, allowing for quick easy viewing, and replacement and servicing without special tools or skills.

- .3 Provide ventilated clear polycarbonate cover for each thermostat located in finished areas, and wire type guard for each thermostat located in unfinished areas and in areas such as mechanical rooms where thermostat is subject to damage.
- .4 Unless otherwise indicated, mount room thermostats in accordance with requirements of barrier-free requirements.
- .5 Provide stand-off mounting and insulated sub-base for thermostats on outside walls.
- .6 Provide control wiring and connections associated with installation of electric or electric-electronic thermostats.
- .7 Prior to ordering, review product finishes with Consultant.
- .8 Prior to roughing-in, review installation locations with Consultant.

3.06 INSTALLATION OF TEMPERATURE AND HUMIDITY SENSORS

- .1 Stabilize sensors in locations, for minimum field adjustments or calibrations.
- .2 Install in locations readily accessible and adaptable to each type of application, allowing for quick easy viewing, and replacement and servicing without special tools or skills.
- .3 Outdoor Installation:
 - .1 Protect from solar radiation and wind effects by non-corroding shields.
 - .2 Install in NEMA 4 type unless otherwise noted, enclosures.
- .4 Duct Installations:
 - .1 Do not mount in dead air space.
 - .2 Locate within sensor vibration and velocity limits.
 - .3 Securely mount extended surface sensor used to sense average temperature.
 - .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
 - .5 Support sensor element separately from coils, filter racks.
- .5 Averaging Duct Type Temperature Sensors:
 - .1 Install averaging element horizontally across ductwork starting 305 mm from top of ductwork.
 - .2 Run each additional horizontal run no more than 305 mm from one above it.
 - .3 Continue until complete cross-sectional area of ductwork is covered.
 - .4 Use multiple sensors where single sensor does not meet required coverage.
 - .5 Wire multiple sensors in series for low temperature protection applications.
 - .6 Wire multiple sensors separately for temperature measurement.
 - .7 Use software averaging algorithm to derive overall average for control purposes.
- .6 Thermowells:
 - .1 Install for piping installations.
 - .2 Locate well in elbow where pipe diameter is less than well insertion length.
 - .3 Thermowell restricts flow by less than 30%.
 - .4 Use thermal conducting paste inside wells.

3.07 INSTALLATION OF GAS DETECTION SYSTEMS

- .1 Provide gas detection system sensor/transmitter and control panel equipment for areas as noted.
- .2 Prior to installation, review locations of equipment with Consultant.
- .3 Provide 24 V wiring in conduit to control panels and from each panel to associated sensor/transmitter units, in accordance with electrical work of Division 26 and system manufacturer certified wiring schematics. Provide 24 V interlock wiring to exhaust fan starters in accordance with control requirements.

3.08 ELECTRICAL AND CONTROL WIRING

- .1 Perform control wiring work for control systems except:
 - .1 Line voltage power wiring connections to equipment and panels, unless otherwise noted.
 - .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.
 - .4 Wiring under work of Division 26.
- .2 Unless otherwise noted, install wiring in conduit. Unless otherwise noted, provide liquid-tight flexible conduit for final 600 mm connections to sensors and transmitters, and wherever conduit extends across flexible duct connections.
- .3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.
- .4 Perform wiring and connection work in accordance with certified wiring schematics and instructions, and wiring standards in accordance with electrical work of Division 26.
- .5 Coordinate controls telecommunications wiring with requirements of Division 27 telecommunications contractor.

3.09 IDENTIFICATION AND LABELLING OF EQUIPMENT AND CIRCUITS

- .1 In accordance with Section 23 05 53 - Identification for Piping and Equipment for Mechanical.
- .2 Identify equipment and wiring as follows:
 - .1 Enclosures and Components:
 - .1 Engraved laminated nameplates.
 - .2 Prior to manufacture of nameplates, review nomenclature, print sizes and colours with Consultant.
 - .2 Wiring:
 - .1 Numbered sleeves or plastic rings at both ends of conductor.
 - .2 Numbering corresponding to conductor identification on shop drawings and as-built record drawings.

3.10 FIELD QUALITY CONTROL

- .1 Arrange for system manufacturer authorized technician to perform Work unless otherwise noted.

- .2 Inspection, Start-Up, Testing and Verification:
 - .1 When control work is complete, check installation of components and wiring connections, make required adjustments, and coordinate adjustments with personnel doing HVAC testing, adjusting, and balancing work.
 - .2 When installation is complete, review and inspect installation, test, and verify operations.
 - .3 Check, test, adjust and verify operation of products.
 - .4 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC, for equipment/system manufacturer certification requirements.
 - .5 For Laboratory HVAC Air Controls and Instrumentation requirements refer to Part 3 Execution article - Installation of Laboratory HVAC Air Controls And Instrumentation. Integrate work with laboratory system integrator.
 - .6 Refer to additional requirements of Section 23 00 15 - Common Work Results for Mechanical.
- .3 Prepare testing and verification reports, signed by testing technician. Submit reports with compliance certificates to Consultant.

END OF SECTION

1. General

1.01 RELATED REQUIREMENTS

- .1 Unless otherwise noted, this Section is common to each Section of Division 26, Division 27 and Division 28, and supplements each Section and read accordingly.
- .2 Division 00 and Division 01.
- .3 Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or 01 to take precedence, as confirmed with Owner and reviewed with Consultant prior to Bid submission.
- .4 Advise product manufacturer and vendors, and trades of each Section, of requirements of this Section. Product manufacturers and vendors are responsible for complying with specified product requirements.

1.02 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.1-[24], Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 CSA C235-[19], Preferred Voltage Levels for AC Systems up to 50 000 V.
- .2 Institute of Electrical and Electronics (IEEE):
 - .1 IEEE Standards Dictionary.
- .3 National Research Council Canada (NRC):
 - .1 NBC-[2020], National Building Code of Canada.

1.03 DEFINITIONS

- .1 Electrical and electronic terms, unless otherwise defined in Specifications or on Drawings, are those defined by IEEE Standards Dictionary.
- .2 AHJ: Authority Having Jurisdiction.
- .3 As noted: Directs reader to refer to schedules, drawings (layouts, riser diagrams, schematics, details) and Specification for additional information.
- .4 BAS: Building Automation System. Equivalent terms include Building Management System (BMS), Energy Management and Control System (EMCS) or Facility Management System (FMS). Typically, generically referenced in Divisions other than Division 25. Refer to Division 25 for final terminology used and system requirements.
- .5 Compliance Certificates: Approval documentation of products or installation work issued by AHJ or product manufacturers, as specified.
- .6 Concealed: Hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.

- .7 Delete or Remove (and tenses of delete or remove): Disconnect, make safe, and remove obsolete materials in planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling and wiring from electrical component to panel, taking care not to damage adjacent assemblies designated to remain. Legally dispose of deleted items off site. Patch and repair/finish surfaces to match adjoining similar construction. Re-program systems to suit deletions. Revise documentation identifications to suit deletions. Retain items indicated as removed and salvaged. Retain items indicated as removed and reinstalled.
- .8 Demolish: Delete or remove, and detach items from existing construction and if not indicated as retained or salvaged, legally dispose of items off site. Retain items indicated as removed and salvaged, or removed and reinstalled.
- .9 Electrical Divisions: Typically, refers to Divisions 26, 27, 28 and other Divisions as specifically noted and which work as defined in Specifications or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- .10 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
- .11 Exposed: Work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
- .12 Finished: When in description of area or part of area or product which receives finish such as paint, or in case of product may be factory finished.
- .13 Install (and tenses of install): Secure in position, connect, test, adjust, verify and certify complete, ready for its intended use.
- .14 Local: In context to authorities or codes or standards, means of place of Work, unless otherwise noted.
- .15 Mechanical Divisions: Typically, refers to Divisions 21, 22, 23, 25 and other Divisions as specifically noted and which work as defined in Specifications or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
- .16 Professional Engineer: Individuals registered or licensed in Place of Work, by respective provincial or territorial associations that regulate practice of engineering in Canada.
- .17 Provision or provide (and tenses of provide): In context of products, means supply, install and test complete, ready for its intended use.
- .18 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, check for proper working condition and reinstall them where indicated.
- .19 Remove and Salvage: Detach items from existing construction and deliver them ready for reuse, to onsite storage areas, as reviewed with Consultant.
- .20 Supply: Procure, arrange for delivery to site, inspect, accept delivery and administer supply of products. Distribute to areas and provide manufacturer assistance for required onsite testing, initial start-up, programming, basic commissioning and verification work.
- .21 Wherever words "indicated", "shown", "noted", "listed", "scheduled" 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", "noted" or "scheduled" in Contract Documents. When such references are used and do not identify exactly where in Contract Documents to refer to, examine issued Contract Documents and if unable to locate, submit request for information to Consultant.

- .22 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 satisfaction of", or "submitted to" Consultant.

1.04 CONTRACT DOCUMENTS

- .1 Specification is typically generally arranged in coordination with guidelines of Construction Specifications Institute/Canadian Specifications Canada (CSI/CSC) 50 Division MasterFormat.
- .2 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 as complementary. Perform Work that is shown, specified, noted or reasonably implied on drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
- .3 Sections of Specifications generally designate a basic unit of work, and Sections are read as whole.
- .4 Except where specifically noted, Specification does not typically indicate specific number of items or quantities 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.
- .5 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and materials. Take accurate measurement of building on site. Do not scale Drawings, and do not use Drawings for prefabrication work.
- .6 Drawings convey scope of work and do not show architectural and structural details. Provide fittings, offsets, transformations and similar items required as a result of obstructions and other architectural or structural details not shown on Drawings.
- .7 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment or materials, other equipment or systems being installed, and of building, at no additional cost to Contract.
- .8 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. Review starter, MCC, VFD, and motor specification requirements of both Electrical and Mechanical Divisions specifications and drawings, prior to Bid submission. Review and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .9 If there is conflict or discrepancy between, among or within any provisions of Contract Documents, provisions establishing higher quality, manner or method of performing the Work, using more stringent standards, prevails, with intent that provisions which produce higher quality with higher levels of safety, reliability, durability, performance and service prevails.
- .10 Upon finding discrepancies in, or omissions from Contract Documents, or having doubt as to their meaning or intent, notify Consultant.
- .11 Language within Specification is in many cases written in imperative mode for brevity. Clauses containing instructions or directions are directed to Contractor.
- .12 Drawings and Specifications are 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.

1.05 METRIC AND IMPERIAL MEASUREMENTS

- .1 Generally, metric units of measurement (typically SI) are given in Sections of Specification. Measurement conversions may be generally "soft" and rounded off from imperial units. Industry common standard units also are specified. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable governing code requirements, and as applicable, make accurate measurements onsite. Where significant discrepancies are found, notify Consultant for direction.
- .2 Some units are specified in imperial units with use based on common trade terms.

1.06 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 Consultant, prior to Bid Submittal, existing site conditions that will or may affect performance of Work in accordance with Documents. Failure to do so will not be grounds for additional costs.

1.07 SUBMITTALS

- .1 Submit electronic copies of submittals, unless otherwise noted.
- .2 Submit product data and shop drawings as specified in Sections.
- .3 Where required by AHJ, provide submittals to such authorities for review and approval. Obtain submission requirements from AHJ. Before making changes requested by AHJ, review with Consultant. Where required for permit approvals, submit plans before commencement of work.
- .4 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .5 Shop Drawings:
 - .1 Where specifically specified for products or work, submit shop drawings stamped and signed by Professional Engineer.
 - .2 At start-up meeting, review with Consultant, products for including in shop drawing submission. Prepare and submit list of products to Consultant for review.
 - .3 Properly identify each shop drawing or product data sheet, with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
 - .4 Limit shop drawing submissions specifically to product (not family of products), without extraneous materials such as manufacturer brochures and sales materials.
 - .5 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.
 - .6 Obtain shop drawings for submission from product manufacturer authorized representatives and supplemented with additional items specified herein.

- .7 Do not order product until respective shop drawing review process has been properly reviewed with Consultant.
- .8 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.
- .9 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 for resubmitted.
- .10 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:
 - .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) - When Consultant review of shop drawing is final, Consultant to stamp shop drawing as respectively stated.
 - .2 "REVISE & RESUBMIT" - When Consultant review of shop drawing is not final, Consultant to stamp shop drawing as stated, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant notations and resubmit.
- .11 Submit for review, shop drawings showing in detail design, construction, and performance of equipment and materials as requested in Specification. Prior to ordering and delivery of product to site, submit shop drawings for Consultant review and recommendations for acceptance. Prepare and submit following as applicable to respective product submissions:
 - .1 Product data, types and ratings (including short circuit withstand ratings on major equipment).
 - .2 Operating instructions and sequence of operations.
 - .3 Equipment dimension drawings including required clearances and service access requirements.
 - .4 Mounting arrangements.
 - .5 Equipment loads (self-weight, operating weight).
 - .6 System block diagrams.
 - .7 Connection wiring schematic diagrams.
 - .8 Functionality with integrated systems.
 - .9 Manufacturer certification of current model production.
 - .10 Certification of compliance to applicable codes.
 - .11 Spare parts.
 - .12 Maintenance schedules.
 - .13 Other items as listed in Specifications.
- .12 Identify with products, types of finishes and colours of final finishes. Submit colour samples/swatches.
- .13 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories and other items shown to verify coordinated installation.
- .14 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
- .15 Indicate on drawings, clearances for operation, maintenance, and replacement of equipment devices.

- .16 Supply opening sizes and locations to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
 - .17 Submit product data of field applied glues, adhesives, solvent cements, paints, caulking, sealants, firestopping coatings and other similar materials, for Consultant review of VOC limits and chemical component limitations.
 - .18 Indicate products having requirements for installation and energizing onsite soon after delivery to maintain manufacturer warranty and service life.
 - .19 Submit detailed matrix identifying responsibilities related to door hardware and security devices.
 - .20 Submit manufacturer documentation on start-up and operating procedures.
 - .21 Submit manufacturer recommended maintenance schedules and procedures.
 - .22 Submit manufacturer recommended spare parts and maintenance materials and tools.
- .6 Other Submittals:
- .1 Electrical distribution system single line riser drawings.
 - .2 Fire alarm system riser drawings.
 - .3 Interference drawings.
 - .4 Layout drawings of equipment and access doors.
 - .5 Copies of reflected ceiling plan drawings and wall elevation drawings showing proposed access door locations.
 - .6 Sleeving drawings: Dimensioned location drawings indicating required sleeves and formed openings in structural poured concrete or precast concrete construction or in roofing, and locations of cutting or drilling required for work.
 - .7 Detailed section drawings of ceiling spaces.
 - .8 Backboard drawings.
 - .9 Drawing details of:
 - .1 Housekeeping pads (concrete pads).
 - .2 Inertia pads.
 - .3 Bases, supports, and anchor bolts.
 - .4 Seismic restraints as required.
 - .10 Permits and Fees:
 - .1 Determine appropriate respective AHJ for Work.
 - .2 Prior to start of construction, make application for approvals from AHJ, and obtain permits.
 - .3 Prior to start of Work, submit copy of permit or notification form and notification number issued by AHJ.
 - .11 Sustainability: Submit in accordance with Division 01 requirements.
 - .12 Samples:
 - .1 Submit samples for products as noted.
 - .2 Unless otherwise noted, do not use samples for construction of Work.
 - .3 Include:
 - .1 Product finishes: Colour swatches/chits.
 - .2 Other items as noted herein this Section and in other Sections.
 - .13 Manufacturer procedures and recommendations for product onsite testing and verification.

- .14 Field Quality Control Reports:
 - .1 Manufacturer Field Reports: Submit, manufacturer certified report, verifying compliance of Work.
 - .2 Testing and Verification Reports: Submit testing and verification reports signed by testing technician for products as specified.
 - .3 Power System Studies: Submit studies as specified including final power system studies performed, documented and recommended for acceptance.
 - .4 Fire alarm system testing and verification report of each component of work. Provide devices certified working and in proper order.
- .15 Compliance Certificates:
 - .1 Upon completion field quality control work, submit compliance certificates verifying installation and performance of installed systems and equipment.
 - .2 Upon completion of the Work submit certificate of acceptance from AHJ.

1.08 AS-BUILT DRAWINGS

- .1 As work progresses at site, clearly mark in red in neat and legible manner on set of bound white prints of Contract drawings, changes and deviations from routing of services and locations of equipment shown on drawings, on daily basis, as required for Work. Use notes marked in red. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date, and available for periodic review. Mark changes as work progresses and as changes occur. Include following with as-built set:
 - .1 Dimensioned location of inaccessible concealed work.
 - .2 Locations of control devices with identification for each.
 - .3 Location and identification of devices in concealed locations such as accessible ceiling spaces and raised floors.
 - .4 For underground ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories, as applicable, and locate and identify dimensions from benchmarks.
 - .5 Location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
 - .6 Location and identification of main junction boxes and main pull boxes.
 - .7 Location of fire alarm devices and addresses of devices. Identify fire alarm zones.
 - .8 Identify routing and location of concealed conduits/ducts of diameter 50 mm and greater.
 - .9 Where applicable, changes to existing electrical systems, control systems and low voltage control wiring.
 - .10 Other items noted on drawings.
 - .11 Other items noted within Specifications.
- .2 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows:
"AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW ELECTRICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
- .3 Submit copies to Consultant for review and comments, and make corrections as recommended by Consultant.
- .4 System Riser Displays:

- .1 Prepare and submit for review "as-built" CAD drawings as follows:
 - .1 Electrical distribution riser diagram record of entire electrical distribution system up to and including line side connections to panelboards.
 - .2 Fire alarm system riser diagram record of entire system.
- .2 Revise drawings incorporating any Consultant comments and obtain Consultant recommendations acceptance.
- .3 Size diagrams same size as issued full size drawings. Mount final reviewed by Consultant, riser diagrams on 10 mm thick foam core with plexiglass cover, and hardware suitable for wall mounting.
- .4 Mount and locate final version of electrical distribution system riser diagram in areas as follows:
 - .1 Main electrical room.
 - .2 Sub-electrical rooms as noted.
- .5 Mount and locate final version of fire alarm system riser diagram in locations as specified in Section 28 46 00 - Multiplex Fire Alarm and Voice Communications Systems.
- .5 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 approval of Owner and reviewed with and recommended for acceptance by Consultant.
- .6 For projects with phased turnover of project (refer to Division 01), review with Consultant completeness of as-built drawings prior to turnover of an area. Make copies of hand drawn interim as-built drawings available to Owner maintenance personnel.
- .7 Prepare and submit for review with record drawings, a neat, clear, properly identified, "as-built" electrical distribution riser diagram record drawing (in CAD format and release version reviewed with Consultant) of entire electrical distribution system up to and including line side connections to panelboards. Make building and room outlines reflecting "as-built" outlines. Include in diagrams for feeder types and sizes, conduit sizes, breaker, switchboard and distribution panel ratings, and other electrical equipment ratings. Submit sample version to Consultant for review and comments prior to final manufacturer. Size diagrams same size as issued full size Drawings. Mount riser diagrams on minimum 10 mm thick foam core complete with mylar finish cover, and hardware suitable for wall mounting in main electrical room.
- .8 Include on single lines, panelboard locations identified by room numbers below panel. When specific identified location is not available, identify nearest available room number followed by triangle (Δ) flagging approximate location. Encircle various loads by Building Wings (where applicable) for ease of identification. Group lighting loads on panelboards on top of panel. Identify motor control centres, VFDs and splitters similar to panelboards. Identify fuse sizing including existing equipment where there is no difficulty in obtaining information. Review exact requirements with Consultant prior to commencing work.
- .9 Replace existing posted single line electrical distribution drawings with revised drawings reflecting renovations and revisions to electrical distribution equipment. Provide drawings of type matching existing as confirmed with Owner and reviewed with Consultant. Supply electronic files of format confirmed with Owner and reviewed with Consultant for following:
 - .1 Fire alarm system test report devices and addresses.
 - .2 Telecommunications network cabling system test report devices and labelling of each device and cable.

- .10 Submit electronic version of completed reproducible as-built drawings with Operating and Maintenance (O & M) Manuals.

1.09 OPERATION AND MAINTENANCE (O & M) MANUALS

- .1 Prepare and submit project specific, indexed copies of equipment manufacturer O & M instruction data manuals. Consolidate each copy of data in identified hard cover three "D" ring binder.
- .2 Operating and maintenance instructions relate to job specific equipment supplied under this project and relate to project building. Language used in manuals contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system/equipment.
- .3 Supply manuals in English language.
- .4 Include electronic PDF version saved on USB type flash drives.
- .5 Prepare O & M manuals for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .6 For each system and equipment identify manufacturer name, type, model year, ratings (performance, capacity, electrical data as applicable) and serial number.
- .7 O & M Data: Obtain operation and maintenance data for products for incorporation into manuals. Include following:
 - .1 Front Cover Clearly Labelled: Project name label; wording - "Electrical Systems Operating and Maintenance Manual"; with specific system/equipment name highlighted, and date.
 - .2 Introduction sheet listing Subcontractor and trades names, street addresses, telephone number and e-mail addresses.
 - .3 Equipment manufacturers authorized distributor, telephone number, e-mail and company website.
 - .4 Table of Contents sheet, and corresponding index tab sheets.
 - .5 Copy of each reviewed shop drawing. Limit shop drawing documentation to specific product requirements as specified for Shop Drawings.
 - .6 Product manufacturer name, type, model year, capacity and serial number.
 - .7 Description of systems and their controls. Include systems architecture and operating data.
 - .8 Parts lists with catalogue numbers.
 - .9 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .10 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .11 Colour-coding charts.
 - .12 Safety precautions.
 - .13 Maintenance and Operating:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Schedules of tasks, frequency, tools required and task time.
 - .3 Recommended spare parts and maintenance materials for systems and equipment.
 - .4 Contact names and addresses of servicing companies and locations where to obtain replacement parts.

- .14 Performance Data:
 - .1 Equipment manufacturer certified factory test reports.
 - .2 Equipment manufacturer certified performance datasheets with point of operation as left after commissioning is complete.
 - .3 Equipment performance certified verification test results.
 - .4 Special performance data as specified.
- .15 Procedures in event of equipment failure.
- .16 Copies of inspection reports or certificates issued by AHJ.
- .17 Copies of panelboard typed directories of circuit breakers and circuits.
- .18 Copies of warranties.
- .19 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .20 Other items noted within Specifications.
- .8 Provide operating instructions on signage for specific equipment/systems as noted.
- .9 Submit copies of draft O & M manuals to Consultant in format reviewed with and recommended for acceptance by Consultant. Combine material as specified and not as individual submissions.
- .10 Make changes as reviewed by and recommended by Consultant and re-submit.
- .11 Additional Data: Prepare and insert into O & M manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .12 Prepare and submit final reviewed with Consultant O & M manuals, with Consultant comments incorporated. Submit as directed in Division 01.

1.10 CLOSEOUT SUBMITTALS

- .1 Prior to application for Substantial Performance of the Work, submit items and documentation noted, including following:
 - .1 O & M Manuals.
 - .2 As-built record drawings and associated data.
 - .3 Extended warranties for equipment as noted.
 - .4 Operating test certificates.
 - .5 Final commissioning reports.
 - .6 Identified keys for equipment and/or panels for which keys are required, and other items required to be submitted.
 - .7 Other data or items as noted.

1.11 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials as specified, in accordance with Division 01 and manufacturer instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labeled with manufacturers name and address.
 - .2 Review and coordinate equipment deliveries with manufacturers and suppliers, and Consultant so equipment is delivered to site when it is required, or so it can be stored.

- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in accordance with manufacturers recommendations in clean, dry, and well-ventilated area onsite, as confirmed with Owner and as reviewed with Consultant.
 - .2 Store and protect products from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new. Remove rejected material and equipment site.
 - .4 Touch up damage to factory finishes. Use finishes to match factory finishes. Do not paint over nameplates or labels.
 - .5 Hoisting and Transporting:
 - .1 Hoist and transport materials and equipment as required.
 - .2 Coordinate with Prime Contractor or General Contractor.
 - .3 Review procedures with Consultant.
 - .4 Review use of elevators and Owner permissions with Consultant. Review limitations of dimensions and loading of elevators that are permitted for use. Where such elevators are permitted for use, prepare schedule of use, detailing date and time frame, materials and equipment being transported and loads. Submit copy for Consultant review and recommendations for acceptance.
 - .5 Refer to requirements of Division 01.
- .4 Develop Construction Waste Management Plan in accordance Division 01.
- .5 Packaging Waste Management: Remove for reuse as specified in Division 01.

1.12 QUALITY ASSURANCE

- .1 Pre-Installation Meeting: Convene pre-installation meeting minimum one week prior to beginning onsite installations as reviewed with Consultant to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordinate with other building subtrades.
 - .4 Review manufacturer installation instructions and warranty requirements.
- .2 Submit following as specifically referenced for products in respective Sections, and as reviewed with Consultant:
 - .1 Factory inspection and test report for equipment. Include copy of each report with operating and maintenance manual project close-out data.
 - .2 Manufacturer/supplier installation compliance certificates.
 - .3 Onsite post installation test reports.

1.13 QUALITY OF WORK

- .1 Perform work so that items are and remain plumb, square and straight. Provide materials and equipment that are free from warping, twisting and other defects.
- .2 Install products in accordance with manufacturer instructions and recommended usage, unless otherwise noted and suiting intended installation requirements. Obtain instructions from manufacturer representative on special installation procedures.
- .3 Perform work in accordance with requirements of AHJ.

- .4 Where installation procedures conflict, review with Consultant prior to proceeding with installation and obtain direction.
- .5 Run exposed conduit and duct runs including runs in ceiling spaces, parallel to building lines unless otherwise noted. Mount panels, boxes, covers, and such other products in similar manner.
- .6 Replace bolts and nuts in "stripped" condition. Replace bolts and nuts in "cross threaded" condition.
- .7 Avoid connection between dissimilar metals. Where such applications cannot be avoided, provide compound or other means recommended for such applications to prevent effects of contact between dissimilar materials.
- .8 Avoid use of material that corrodes when exposed to moisture, in wet locations or damp locations.
- .9 Conceal rough-in work in areas except where surface installations are specifically indicated. Where this becomes impossible and before proceeding with work, review with Consultant, to determine what adjustments to make.
- .10 Maintain superintendent onsite at times when work is being performed.

1.14 REGULATORY REQUIREMENTS

- .1 Comply with requirements of:
 - .1 Governing Ministry of Labour.
 - .2 Workplace Hazardous Materials Information System (WHMIS).
 - .3 Occupational Health and Safety Act.
 - .4 AHJ governing codes, regulations and standards.
- .2 Where code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, latest published edition adopted by and enforced by AHJ, unless edition date is specified. Comply with revisions, bulletins, supplementary standards or amendments issued by AHJ. Comply with federal and provincial codes and standards. Prior to start of Work, confirm edition dates being enforced for Project.
- .3 Where regulatory codes, standards and regulations are at variance with each other, or with Drawings or Specification, more stringent requirement applies. In doubt, review with Consultant.
- .4 Comply with requirements for barrier free access.
- .5 Perform Work in accordance with requirements of CSA C22.1 and provincial electrical code.
- .6 Perform Work in accordance with requirements of NBC and provincial building code, and codes and standards listed throughout Specification.
- .7 Work is to be performed by journeyperson who perform only work that their certificates permit, or by apprentices under direct onsite supervision of experienced journeyperson, in accordance with requirements of AHJ and local rules and regulations.
- .8 Journeypersons are to have copy of valid trade certificates available at site for review by Consultant.

1.15 DELEGATED DESIGN REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

- .1 Engage Professional Engineers to provide delegated design work of respective Sections, to prepare, design, and sign and seal engineered delegated design submittals.
- .2 Qualifications of Professional Engineers retained by Contractors to perform consulting services and provide engineered delegated designs with regard to Project work, such as seismic engineer, fire protection engineer or structural engineer:
 - .1 Legally qualified to practice professional engineering in Place of the Work.
 - .2 Experienced in work of respective Sections as noted.
 - .3 Carry and pay for errors and omissions professional liability insurance in compliance with requirements of AHJ in Place of the Work.
- .3 Retained engineers professional liability insurance protects Contractor 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 regard to the Work of this Contract.
- .4 Refer to Divisions 00 and 01 for liability insurance requirements:
 - .1 Coverage per General Conditions and Supplementary General Conditions.
 - .2 Insurance policy cannot be canceled or changed in any way without insurer giving Owner written notice.
- .5 Engineered delegated design submittals include, but not be limited to following:
 - .1 REVIT/CAD layout design drawings consisting of minimum 760 mm by 1050 mm detail working drawings of system layout and identifying as applicable:
 - .1 Head-end equipment.
 - .2 Devices.
 - .3 Applicable conduit/piping/ductwork layout and sizing.
 - .4 Applicable electrical point-to-point wiring diagrams.
 - .5 Data essential for proper installation of system.
 - .6 Details, plan view, elevations, and sections of system.
 - .7 Seismic restraints as required.
 - .2 Design data identifying:
 - .1 Calculations of system design listing design data used in preparing calculations, system layout, zoning and sizing, as applicable.
 - .2 Type and design of system.
 - .3 Certification that system has performed in manner intended.
 - .4 List of standards, codes and regulations that preparation of design was based.
 - .3 Manufacturer test data indicating results of factory tests on equipment prior to shipment.
 - .4 Items as noted in other Sections.

- .6 Responsibilities of Retained Engineers:
 - .1 Design, prepare, seal and sign engineered submittals.
 - .2 Perform periodic field reviews, including review of associated mock-ups where applicable, at locations wherever work as described by engineered submittal is in progress, during fabrication and installation of such work.
 - .3 Perform field reviews at intervals as necessary to progress of work.
 - .4 Determine if work is proceeding in general conformity with Contract Documents including reviewed shop drawings and design calculations.
 - .5 Submit field review report after each visit.
 - .6 Submit field review reports to Consultant and AHJ as required.
 - .7 Certifying that work has been supplied and installed in accordance with requirements of Contract Documents, AHJ and engineered submittal.

1.16 PERMITS, CERTIFICATES, APPROVALS AND FEES

- .1 Contact and confirm with AHJ including utility providers, requirements for approvals from such authorities.
- .2 Obtain and pay for permits, inspections and compliance certificates. Give required notices. Submit required applications, shop drawings, electrical distribution system protection device coordination studies, short circuit calculations and other information requested by AHJ.
- .3 Notify Consultant of proposed changes to documents requested by AHJ and obtain Consultant recommendations prior to making changes.
- .4 Provide notification as requested by AHJ, for AHJ to perform onsite inspection of work. Allow sufficient lead time to correct deficiencies in manner not impeding schedule of completion of Work. Where defect, deficiency or non-compliance is found in work by inspection, provide for such inspection including related expenses, making good and return to site, until work is accepted by AHJ.
- .5 Coordinate work inspection reviews and approvals with AHJ ensuring construction schedule is not delayed. Promptly notify deficiencies to Consultant and submit reports and certificates to Consultant.
- .6 Obtain and submit to Consultant, compliance certificates issued by AHJ that verifies Work as installed is in accordance with rules and regulations of AHJ and are acceptable by AHJ.
- .7 Include in each copy of operating and maintenance instruction manuals, copies of compliance certificates issued by AHJ.
- .8 Where electromagnetic locks are installed, ensure required certificates of work with regards to such electromagnetic lock work are obtained.

1.17 ACCEPTABLE PRODUCT MANUFACTURERS AND VENDORS

- .1 Products and services may generally be specified:
 - .1 With listing of acceptable manufacturers, vendors or service companies.
 - .2 With manufacturer model or series numbers listed.
 - .3 Base specified with manufacturer and model or series number.

- .2 Base Bid pricing on products supplied by base specified or listed acceptable companies. Unless otherwise noted, base pricing on model or series where listed. If only base specified company is specified with no other acceptable manufacturers listed, base pricing on base specified product.
- .3 Listing acceptable manufacturers/vendors does not imply automatic acceptance by Consultant or Owner. Ensure that any price quotations received, and submittals made are for products or services that meet or exceed specifications included herein. Ensure that acceptable products 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), and changes to associated or adjacent work resulting from provision of product supplied by manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in spaces where product named as acceptable is used in lieu of base specified product and dimensions of such product differs from base specified product, prepare and submit for review accurately dimensioned layouts of rooms/ceiling plans affected, identifying architectural and structural elements, systems and equipment to prove that product in space will fit and perform properly meeting design intent. There will be no increase in Contract Price for revisions.
- .4 Where products are listed as "equal to" or equivalent to" or "approved equal", other manufacturers may be proposed for review of acceptability by Consultant. Submit RFI with proposed manufacturer and model with detailed product specifications to Consultant during Bidding period. Acceptance is at sole discretion of Consultant and acceptance documented in addendum. Unless acceptance is given, do not include such products in Bid pricing.
- .5 When issued with Documents or requested by Consultant, complete and submit as directed, List of Proposed Acceptable Manufacturers and Vendors, or when directed by Consultant submit separate list of proposed manufacturers and vendors.
- .6 Changes to list of proposed manufacturers and vendors, initiated by Contractor after award of Contract may be considered by Consultant at Consultant discretion. Additional costs for such changes if approved by Owner and reviewed with and recommended for acceptance by Consultant, and costs for review, to be borne by Contractor.

1.18 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment (products). Where products are indicated, scheduled or specified, they establish performance and quality standard, and in some instances, dimensional standard.
- .2 Ensure that selected products meet design intent and specified quality standards, performance criteria and operating characteristics. Ensure that product dimensions, weight and special conditions can be accommodated in spaces designated for installations. Where selected product installation requires changes to base design of architectural or structural nature, or changes to interconnected electrical or mechanical components, costs of such changes is borne by Contractor.
- .3 Product Certifications:
 - .1 Canadian Standards Association (CSA) certifications or Underwriters Laboratories of Canada (ULC) listings markings.
 - .2 References to UL listings of products to include requirements that products are also Underwriters Laboratories of Canada ULC / cUL listed for use in Canada.

- .3 Other certification organizations accredited by Standards Council of Canada to approve electrical equipment may be acceptable subject to approval from electrical AHJ and review with and recommended for acceptance by Consultant.
- .4 Certifications of standards as listed in trade Sections.
- .4 Provide systems and equipment that are most recent and up to date series/version of product available at time of shop drawing review process. Provide software of latest version available and with updates available at time of shop drawing review process. Provide software that is backwards compatible and such that future upgrades do not require hardware replacements or additions to utilize latest software.
- .5 Operating Voltages: In accordance with CSA C235.
- .6 Equipment located in extreme operating conditions: Provide to operate in extreme operating conditions in accordance with CSA C235 without damage to equipment.
- .7 Provide control devices and equipment rated for electrical utility connected line voltage operation, or where required low voltage, and operate at 60 Hz within normal operating limits established by above standard.
- .8 Determine short circuit current ratings at various levels of electrical distribution system and advise mechanical equipment vendors of rating requirements for equipment. Refer to Section 26 05 73 - Power System Studies.
- .9 Factory assemble control panels and component assemblies.
- .10 Products (including associated installation and supporting hardware) located in non-climate controlled environments: Features for corrosion-resistant, weather-resistant, able to withstand various climatic conditions including hot and cold temperatures.
- .11 Products located in public spaces and which are located within hands reach: Features for tamper-proof and impact-resistant.
- .12 Supply inserts, anchors, bolts, sleeves, ferrules and other items built into work of other Divisions, complete with necessary templates, instructions and assistance for locating and installing.
- .13 Utilize materials of same manufacturer for similar aspects of work, where practical. Utilize same common manufacturer for wiring devices, such as switches and receptacles, whether installed loose or in pre-manufactured component. Coordinate with each supplier and ensure conformance with this requirement. Identify deviations to Consultant and obtain Owner approval of change prior to proceeding with work.
- .14 Systems that are of technology that changes rapidly and are forever evolving and changing, may result in systems or equipment that may be outdated by time of installation. Include provisions allowing Owner option to select most updated technology. During shop drawing submission period include provisions for minimum 15 working days review time for Owner to review degree of technology of each system/equipment and determine acceptance and give Owner right to substitute more advanced technology subject to negotiated pricing and time constraints of project.

1.19 CHANGES IN THE WORK

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of any work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation detailing proposed cost for executing change or revision.

- .2 Submit quotation as 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 noted in Divisions 00 or 01, following additional requirements apply to 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 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. For mechanical work material costs, refer to additional requirements of Section 23 00 10 - Mechanical Work General Instructions.
 - .3 Electrical labour unit costs are in accordance with National Electrical Contractors Association Manual of Labor Units at normal level, less 25%.
 - .4 Mechanical labour unit costs are in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%.
 - .5 Costs for journeyman and apprentice labour to not exceed prevailing rates at time of execution of Contract and to reflect actual personnel performing work.
 - .6 Cost for site superintendent to not exceed 10% of total hours of labour estimated for change or revision, and change or revision includes site superintendent involvement.
 - .7 Costs for rental tools or equipment to not exceed local rental costs.
 - .8 Overhead percentage deemed to cover quotation costs other than actual site labour and materials, and rentals.
 - .9 Quotations, including those for deleted work, include required change to Contract time.
- .4 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit proper quotation enabling Consultant to expeditiously process quotation and issue Change Order will not be grounds for any additional change to Contract time.
- .5 Make requests for changes or revisions to work in writing to Consultant and, when accepted by Owner, Notice of Change to be issued.
- .6 Do not execute any change or revision until written authorization for change or revision has been obtained from Owner and reviewed with Consultant.

1.20 PROGRESS PAYMENT BREAKDOWN

- .1 Prior to submittal of first progress payment draw, submit detailed breakdown of work cost to assist Consultant in reviewing and recommending for acceptance progress payment claims.
- .2 Payment breakdown is subject to Owner approval and Consultant review and recommendations. Progress payments will not be processed until approved breakdown is in place. Breakdown to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including 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 they will be indicated on progress draw.

1.21 WARRANTY

- .1 Except where otherwise specified in Divisions 00 and 01, warrant work to be in accordance with Contract Documents and free from defects for a period of 1 year from date of issue of Certificate of Substantial Performance of the Work.
- .2 Where equipment includes extended warranty period, first year of warranty period is governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are direct from equipment manufacturer or supplier to Owner. Submit signed and dated copies of extended warranties with shop drawings and O & M manuals.
- .3 Warranty includes parts, labour, travel costs and living expenses incurred by manufacturer authorized technician to provide factory authorized onsite service.
- .4 Repair and/or replace 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 staff or agents is exempted.
- .5 Do not include Owner deductible amounts in warranties.
- .6 Warranties commence from time of Substantial Performance of the Work, regardless of what is noted within following Sections of Specification. Provide "bridging" or additional extended warranty period required from time that material is purchased until time of Substantial Performance of the Work.
- .7 Visit building during warranty period with Owner representatives. Owner organizes these visits. At these meetings, Owner representatives review performance of systems. When performance is satisfactory, then no further action is required. When unsatisfactory, then correct deficiencies. These site visits to occur:
 - .1 Once during first month of building operation.
 - .2 Once during third month of building operation.
 - .3 Once between fourth and tenth month in a season opposite to first and third month visits.

1.22 REQUEST FOR INFORMATION (RFI)

- .1 Review contract documents for information prior to issuance of RFI during performance of Work. Where it is determined, at discretion of Owner and review with Consultant, that information requested in RFI was readily identifiable as part of Contract Documents, respective trades Contractor to be back-charged against their contract amount for time spent by Consultant and Owner in preparing response to RFI. Minimum amount of \$150 CDN to be back charged against contract amount for any response to readily identifiable RFI.

2. Products (Not Used)

3. Execution (Not Used)

END OF SECTION

1. GENERAL

1.01 RELATED REQUIREMENTS

- .1 Section 26 00 10 - Electrical Work General Instructions.
- .2 Unless otherwise noted, this Section is common to each Section of Division 26, Division 27 and Division 28, and supplements each Section and read accordingly.
- .3 Advise product manufacturer and vendors, and trades of each Section, of requirements of this Section. Product manufacturers and vendors are responsible for complying with specified product requirements.

1.02 REFERENCE STANDARDS

- .1 American National Standards Institute/Telecommunications Industries Association (ANSI/TIA):
 - .1 ANSI/TIA-569-E-[2019], Telecommunications Pathways and Spaces.
- .2 American Society of Mechanical Engineers/CSA Group (ASME/CSA):
 - .1 ASME A17.1-[2019]/CSA B44-[19], Safety Code for Elevators and Escalators (Binational standard with ASME A17.1).
- .3 ASTM International (ASTM):
 - .1 ASTM C679-[15(2022)], Standard Test Method for Tack-Free Time of Elastomeric Sealants.
 - .2 ASTM D6904-[03(2022)], Standard Practice for Resistance to Wind-Driven Rain for Exterior Coatings Applied on Masonry.
 - .3 ASTM G21-[15(2021)e1], Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .4 CSA Group (CSA):
 - .1 CSA A23.1-[19]/CSA A23.2-[19], Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CSA B44.1-[19]/ASME A17.5-[2019], Elevator and Escalator Electrical Equipment.
 - .3 CSA C22.1-[24], Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .4 CSA C22.3 No. 1-[2020], Overhead Systems.
 - .5 CSA C22.3 No. 7-[20], Underground Systems.
- .5 International Organization for Standardization (ISO):
 - .1 ISO 10664:[2014], Hexalobular Internal Driving Feature for Bolts and Screws.
- .6 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S101-[14-REV3], Standard Method of Fire Endurance Tests of Building Construction and Materials.
 - .2 CAN/ULC-S102-[2019-(R2024)], Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .3 CAN/ULC-S115-[2023], Standard Method of Fire Tests of Firestop Systems.
 - .4 CAN/ULC-S524-[2019], Standard for the Installation of Fire Alarm Systems.

- .5 CAN/ULC-S1001-[2023], Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.03 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, weight, service clearance requirements, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Where specifically specified for products or work, submit shop drawings stamped and signed by Professional Engineer.
 - .3 Include:
 - .1 Access Doors: Sample of each proposed type of access door where supplied under work of this Division, as well as electronic copies of reflected ceiling plan drawings and wall elevation drawings showing proposed access door locations.
 - .2 Equipment Nameplate and Signage: With proposed nomenclature, print type, symbols, sizing and colours.
 - .3 Firestopping and Smoke Seal Materials: With installation drawings and specific ULC certifications.
- .3 Sample Submittals:
 - .1 Submit samples of following:
 - .1 Paint colour chits or swatches.
 - .2 Each type of access door.
 - .3 Nameplates, labels and signage. Present on sample board.
- .4 Submit compliance certificates, and testing and verification reports, as noted.

2. Products

2.01 SUSTAINABILITY REQUIREMENTS

- .1 Refer to and comply with sustainability requirements of Division 01.
- .2 Provide materials with applicable volatile organic compounds (VOC) requirements. Materials include but not limited to:
 - .1 Sealants.
 - .2 Air filters.
 - .3 Paints, primers and coatings.
 - .4 Adhesives.
 - .5 Insulations.
 - .6 Wood or composite wood products.
 - .7 Other materials as noted in Sections.

2.02 FINISHES

- .1 Factory finish metal enclosure surfaces by application of rust-resistant primer inside and outside, and at least two-coats of finish enamel, with colour finish. Before manufacturing, review finishes with Consultant during shop drawing submission.
- .2 Paint outdoor electrical distribution equipment in weather-resistant, corrosion-resistant finish of equipment manufacturer standard ANSI green finish colour, unless otherwise noted.
- .3 Paint indoor switchgear and electrical distribution equipment enclosures in equipment manufacturer standard ANSI gray finish colour, unless otherwise noted.
- .4 Refer to trade sections for additional painting requirements.
- .5 Submit sample paint colour chits or swatches.
- .6 Include touch-up paint matching finishes for each major equipment.

2.03 EQUIPMENT ENCLOSURE DRIP SHIELDS AND WATER INGRESS PROTECTION

- .1 Provide drip shields for protection of surface-mounted equipment enclosures located in climate-controlled areas, from water spray and dripping of liquids. Features of shields:
 - .1 Factory constructed by respective equipment manufacturers.
 - .2 Constructed from non-combustible materials (sheet steel).
 - .3 Enamel painted to match equipment.
 - .4 Prior to painting, surfaces and edges filed or sanded smooth.
 - .5 Where not integrated with top side of enclosure, mechanically supported from equipment with structural steel rods or metal framing or other similar means by equipment manufacturer.
 - .6 Structural support finish painted to match shield.
- .2 Include with equipment shop drawings, detailed dimensions of drip shields, and methods of supporting as applicable.
- .3 Provide equipment with cable or conduit entries sealed with gasketing or waterproof sealant, preventing water from entering enclosure. Unless otherwise noted, do not penetrate drip shields or tops of enclosures with cable or conduit entries.
- .4 Provide enclosure ventilation louvers designed protecting live components from exposure to water spray and dripping liquids.
- .5 Above requirements are additional minimum "sprinkler protection" standards for equipment noted as NEMA 1, NEMA 2 or NEMA 12.
- .6 Provide NEMA 4 rated enclosures in non-climate controlled non-hazardous classified areas unless otherwise noted.
- .7 Obtain CSA certification where required by AHJ.

2.04 SLEEVES

- .1 Poured Concrete Construction:
 - .1 Galvanized sheet steel: Minimum No. 16 gauge galvanized steel with integral flange at one end to secure sleeve to formwork construction.
 - .2 Polyethylene: Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses. Use where permitted by AHJ.

- .3 Waterproof sleeves in new poured concrete construction: Schedule 40 waterproof mild galvanized steel pipe with welded-on square steel anchor and water stop plate at sleeve midpoint.
- .2 Masonry and Drywall Construction:
 - .1 Schedule 40 mild galvanized steel pipe.
 - .2 Class 4000 cast iron pipe.
- .3 Interlocking Link Type Mechanical Seals:
 - .1 Synthetic rubber construction.
 - .2 Provides sealing rated of annular space between conduits and sleeves.
 - .3 Protects from galvanic corrosion.
 - .4 Absorbs shocks, sound and vibration.
- .4 Refer to requirements of Division 03.

2.05 FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Refer to Division 07, for requirements for firestopping and smoke seal materials.
- .2 Coordinate responsibilities for materials and work with general trades.

2.06 FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Asbestos-free, elastomeric materials and intumescent materials, for installation in ULC designated firestopping and smoke seal systems. Tested, listed and labeled by ULC in accordance with following:
 - .1 ASTM C679.
 - .2 ASTM D6904.
 - .3 ASTM G21.
 - .4 CAN/ULC-S101.
 - .5 CAN/ULC-S102.
 - .6 CAN/ULC-S115.
- .2 System assemblies and materials provide positive fire, water and smoke seal, and fire-resistance rating (flame, hose stream and temperature) no less than fire-rating for surrounding construction.
- .3 Assembly Rating: As determined by CAN/ULC-S115 which is equal to time rating of construction joint assembly.
- .4 Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of 0 as determined by ASTM G21.
- .5 Exterior exposure applications rain and water resistance: Provide perimeter joint sealant tested in accordance with ASTM D6904 with less than 1 hour tack free time as tested in accordance with ASTM C679.
- .6 Materials are specifically ULC certified with designated reference number for its specific installation. As part of shop drawing submission, submit copies of firestopping drawings with ULC certificate and system number for each specific installation.
- .7 Materials and manufacturers are specifically approved for each application of penetrated surfaces, by FM Global and listed in FM Global Approval Guide. As part of shop drawing submission, submit copies of firestopping drawings with FM Global Approval Guide.

- .8 Materials are 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. Coordinate material requirements with trades supplying abutting areas of materials.
- .9 Provide pre-formed firestop devices for use with non-combustible and combustible raceways, conduit or cable bundles penetrating concrete floors or gypsum walls.
- .10 Provide sealants or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing.
- .11 For typical standard indoor applications for conduit and cable installations to seal openings up to 25 mm, pre-formed firestopping cable discs with features as follows:
 - .1 Approximate Density: 1.6 g/cm³.
 - .2 Mold and mildew resistant.
 - .3 Surface Burning Characteristics: Flame Spread: 0 and Smoke development: 5.
 - .4 Application Temperature: 0 to 40°C.
 - .5 Percent Fill: Up to 100% per tested system.
 - .6 Sound Transmission Classification: 62 (Relates to specific construction).
- .12 For typical standard indoor applications to seal openings up to 1800 mm x 900 mm, ready-to-use, intumescent flexible block as follows:
 - .1 For sealing single or multiple penetrations of openings.
 - .2 For temporary or permanent sealing of cables and cable tray penetrations.
 - .3 For temporary or permanent sealing of conduit penetrations.
 - .4 Halogen, asbestos, solvent free and smoke resistant.
 - .5 Operational immediately after installation.
 - .6 Application Temperature: 5°C to 40°C.
 - .7 Temperature Resistance: Minus 15°C to 60°C.
 - .8 Intumescent Activation: Approximately 200°C.
 - .9 Expansion Ratio (unrestricted): Up to 1:3.
 - .10 Surface Burning Characteristics: Flame Spread Index: 10 and Smoke Development Index: 15.
 - .11 Sound Transmission Classification: STC Rating: 52.
 - .12 Suitable for wet areas when applied with additional silicone coating in accordance with manufacturer directions.
- .13 Applications where fire-rated firestopping cable pathway system is special structurally reinforced, reusable and require no or minimal alterations to firestop component when cables are either added or removed, provide sleeve assembly with features as follows:
 - .1 Re-penetrable cable management device for electrical and telecom cables.
 - .2 Smoke gaskets.
 - .3 50 mm or 100 mm diameter opening models suiting intended applications.
 - .4 Total Length: Approximately 315 mm.
 - .5 Temperature Resistance: Minus 6°C to 100°C.
 - .6 Intumescent Activation: Approximately 160°C.
 - .7 Expansion Ratio (unrestricted): 1:40.
 - .8 Construction: Metal steel with zinc coating, plastic ABS and fabric glass-fibre.

- .9 Structure: Sturdy enough to stand up to constant modification and use, but maintain its ULC firestopping rating.
- .14 Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .15 Supply products of a single manufacturer for use on work of this Division.
- .16 Installer is manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.
- .17 Manufacturer authorized technician services:
 - .1 Onsite inspect and verify each installation and application.
 - .2 Submit test report signed and verified by system installer authorized representative and manufacturer representative.
 - .3 Prepare, sign and submit test report that lists each installation with test results and respective ULC certification and number.
- .18 Acceptable certification also includes certification by Underwriters Laboratories of Northbrook IL, using tests in accordance with CAN/ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".

2.07 ACCESS DOORS

- .1 Refer to Division 08, for access doors requirements.
- .2 Coordinate responsibilities for doors and work with general trades.
- .3 Coordinate location of outlet boxes, junction boxes, pull boxes, and other concealed equipment requiring access, to minimize need for access doors. Determine size, quantity and location of access doors, for ease of access to installation.
- .4 Size access door to suit concealed work for which they are supplied and wherever possible they are to be of standard size for each application, but in any case, of minimum 300 mm x 300 mm for hand entry and 600 mm x 600 mm for body entry.
- .5 Access doors in fire rated ceilings, walls, partitions, and structures, are ULC listed and labelled and of rating to maintain fire separation integrity.
- .6 Identify on reflected ceiling plans and wall elevation drawings, coordinated locations of proposed access door locations and submit to Consultant.

2.08 ACCESS DOORS

- .1 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 are rust resistant steel door panels, with concealed hinges and positive locking and self-opening screwdriver operated lock. Wall type frames are suitable for wall installation and have integral keys for plaster walls. Doors in tile wall are stainless steel and in ceilings are suitable for plaster covering with only frame joint showing. Other doors are prime painted steel.
- .3 Size access door to suit concealed work for which they are supplied, and wherever possible are of standard size for all applications, but in any case, are minimum 300 mm x 300 mm for hand entry and 600 mm x 600 mm 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 are 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 include dish-shaped door and welded metal lath, ready-to-take plaster. Provide plastic grommet for door key access.
- .6 Other access doors are welded 12 gauge steel, flush type with concealed hinges, lock and anchor straps, complete with factory prime coat. Submit to Consultant, details of non-standard door construction details.
- .7 Access doors in fire-rated ceilings, walls, partitions, or structures, are ULC listed and labelled and of rating to maintain fire separation integrity.
- .8 Where access doors are located in surfaces where special finishes are required, they are recessed door type capable of accepting finish in which they are installed so as to maintain final building surface appearance throughout.

2.09 EQUIPMENT BACKBOARDS

- .1 Refer to Division 06 for rough carpentry and Division 09 for painting and provide equipment backboards as specified.
- .2 Coordinate responsibilities and work with general trades.

2.10 EQUIPMENT BACKBOARDS

- .1 FSC (Forest Stewardship Council), G1S (good one side) construction grade fir plywood.
- .2 Containing no added urea formaldehyde.
- .3 Flame retardant prime coat painted on exposed surfaces.
- .4 Minimum 20 mm thick, and as sized on drawings.
- .5 Flame spread rating:
 - .1 In accordance with building code requirements.
 - .2 Typically, maximum flame spread 25, maximum smoke developed 25.

2.11 ESCUTCHEON PLATES

- .1 One-piece or split.
- .2 Finishes:
 - .1 No. 4 finish, type 302 stainless steel.
 - .2 Chrome.
 - .3 Nickel plated brass.
- .3 With matching finished screws for attachment to building surface.
- .4 Sizing: Completely covers sleeve or building surface opening, and fits tightly around conduits.

2.12 ANCHOR BOLTS, LIFTING EYES AND HOOKS

- .1 Provide and set anchor bolts, sleeves, washers, nuts and provide templates to locate positions of bolts. Set sleeves flush with or slightly above top surface or rough concrete. Provide anchor bolts with right-angles bends or hooks, or with square plate washers, threads and nuts for anchoring. Do not use expansion shields or similar devices for anchoring equipment to concrete bases.
- .2 Provide steel lifting eyes and hooks on equipment of type and lifting capacity to accommodate weight of equipment. Provide galvanized steel types or other corrosion-resistant finish for products located in non-climate-controlled areas.

2.13 SECURITY FASTENERS

- .1 Provide security fasteners for products preventing easy access to and easy disassembly.
- .2 Review requirements with Consultant.
- .3 Type:
 - .1 In accordance with ISO 10664.
 - .2 Tamper-resistant, corrosion-resistant, stainless steel security type hexalobular equivalent to Torx head with post in center of head that prevents standard Torx driver from being inserted.
 - .3 Uses specific driver matching heads.

2.14 MAINTENANCE MATERIALS AND SPARE PARTS

- .1 Supply maintenance materials and spare parts as specified in respective Sections.
- .2 Generally, include:
 - .1 One set of spare parts required to service equipment as recommended by respective equipment/system manufacturers.
 - .2 One set of special tools required to service equipment as recommended by respective equipment/system manufacturers.
 - .3 Other items noted within respective Sections.

2.15 ACCEPTABLE PRODUCT MANUFACTURERS/VENDORS

- .1 Firestopping and Smoke Seal Materials:
 - .1 Hilti Canada.
 - .2 Specified Technologies.
 - .3 3M Canada.
 - .4 Tremco.
 - .5 A/D Fire Protection Systems.
 - .6 Nelson.
- .2 Access Doors:
 - .1 Acudor.
 - .2 BAUCO
 - .3 SMS.

3. Execution

3.01 EXAMINATION

- .1 Verification of Conditions:
 - .1 Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for respective product installation in accordance with manufacturer written instructions.
 - .2 Verify that conditions are acceptable for product installation in accordance with manufacturer written instructions and for work of respective Sections.
 - .3 Field verify building and site dimensions prior to fabrication and installation of equipment or materials.
- .2 Inspect conditions visually onsite. When requested by Consultant, inspect in presence with Consultant.
- .3 Report to Consultant, conditions that hinder or obstruct installation work beyond intent of issued Documents.
- .4 Proceed with installation only after these conditions have been remedied, and reviewed with Consultant.

3.02 TEMPORARY SERVICES

- .1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to:
 - .1 Temporary electrical power.
 - .2 Lighting.
 - .3 Heating.
 - .4 Water.
 - .5 Exit pathways.
- .2 Confirm locations of exit pathways are as decided at discretion of Prime Contractor and be illuminated complete with emergency lighting and provided with exit signage and fire alarm devices.
- .3 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems.
- .4 Provide services in accordance with requirements of building codes and AHJ.

3.03 PHASING AND SCHEDULING OF WORK

- .1 Include for scheduling, co-ordination, and construction phasing suiting project as specified in Division 01, or as noted. Prior to start of Work, review phasing requirements with Consultant.
- .2 Perform phasing and scheduling of Work to maintain existing building operations.
- .3 Perform work within occupied spaces and work affecting surfaces adjacent to occupied spaces during and after regular business hours, as coordinated with Owner and reviewed with Consultant. For areas where spaces are used by Owner on a 24-hours basis or over various hours, coordinate hours of work with Owner on a regular basis, suiting Owner schedule. Execute work at times approved by Owner and reviewed with Consultant, so as not to inconvenience Owner occupation or in any way hinder Owner use of building.
- .4 Provide project partial occupancy permits as required throughout project. Provide for each partial permit, compliance certificates for systems.

3.04 LAYOUT AND COORDINATION OF WORK

- .1 Cooperate and coordinate with other Divisions as required for completion of the Work and avoiding interference with work by other Sections. Coordinate locations of conduits, raceways, junction and pull boxes, with other Divisions and other trades.
- .2 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings. Lay out work for execution of work.
- .3 Examine drawings verifying work can be performed without changes to building as noted on plans.
- .4 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.
- .5 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. Prior to proceeding with Work, notify Consultant where any invert, grade, or size is at variance with Contract Drawings.
- .6 Prepare plan and interference drawings of work for coordination with each trade. Prepare detailed section drawings of ceiling spaces, areas of shafts, rooms and ceilings which are highly congested and for which site workers could not solve construction coordination issues. Indicate on section drawings lateral and elevation dimensions of major services within spaces. These drawings propose solutions for trades affected.
- .7 Prepare and submit drawings showing sleeving, recessed and formed holes required in concrete for work. Prepare drawings in conjunction with other trades. Prepare drawings to scale sufficient showing necessary details. Submit for review using same procedures as specified for shop drawings.
- .8 Dimension sleeves, recesses and openings with respect to building elevations and established grid lines.
- .9 Coordinate structural work for support of products with requirements of Division 13 and Structural Consultant as applicable.
- .10 Coordinate concrete work such as housekeeping pads, sumps and bases, required for work, and including required dimensions, operating weight of equipment and location.
- .11 Coordinate depth and routing of excavation required for work, and requirements for bedding and backfill, in accordance with requirements of Division 31 as applicable.
- .12 Coordinate with, instruct and supervise those Divisions doing related work.
- .13 Supply measurements of equipment to other Divisions allowing for necessary openings in their work.
- .14 Locate equipment maximizing usable space. Install raceways, fittings, pull boxes, junction boxes, concealed wiring and cables, close to building structure in order that furring is as small as possible.
- .15 Prior to commencing work, review relevant shop drawings and product data of other Divisions where they affect work of this Section.
- .16 Refer to mechanical drawings when coordinating locations of starters, variable frequency drives, motors, panels, and connected equipment.

- .17 Coordinate various low voltage systems. Perform following:
 - .1 Coordinate with trades of various systems which are interfaced with, monitored by, and integrated to electrical work.
 - .2 Prepare systems coordination drawings detailing related system coordination and integration points.
 - .3 Coordinate wiring work required for equipment and systems but not specified to be done as part of work of other Divisions, including termination points, wiring type and size, and controls.
 - .4 Coordinate security system requirements with successful door hardware supplier and prepare detailed coordination drawings of component installations, sequence of operations, wiring and conduit layouts and division of responsibility between various trades.
 - .5 Review systems requirements for power supplies, communication interface protocols, component back boxes and conduits.
 - .6 Provide onsite technical assistance during testing and commissioning functions of each system.
 - .7 Document coordination and integration requirements and maintain records for submission as part of shop drawings.
- .18 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.
- .19 Where drawings indicate that acoustic tile ceiling is being suspended below structural ceiling, coordinate design of framework used to support suspended ceiling, luminaires, and other components that are mounted within or through ceiling. Unless otherwise noted, do not mount devices to suspended ceiling. Secure and mount to ceiling slab above. Seal ceiling openings to maintain required fire-rating.
- .20 Order products in timely manner meeting project-scheduling timelines. Failure to order products to allow manufacturers sufficient production or delivery time to meet project-scheduling timelines is unacceptable reason to request for use of other suppliers or substitutions.

3.05 INTERRUPTION TO AND SHUT-DOWN OF ELECTRICAL SERVICES AND SYSTEMS

- .1 Coordinate shut-down and interruption to existing electrical services or systems with Owner. Generally, shut-downs may be performed only between hours of 12:00 midnight Friday until 6:00 a.m. Monday morning. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein. Services for operation of existing non-renovated areas of building are to be maintained.
- .2 Upon award of Contract, submit list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform Owner and Consultant in writing minimum 7 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any service or system without such written consent. Shutdowns of some essential services may require additional advance notification time.

- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete work for which shut-down is required are available at site.
- .5 Prior to start of work, confirm methods of procedures with Owner and review with Consultant.
- .6 Where working in close proximity to "live parts" or inside energized panels or energized cubicles of switchboards/substations, provide protection "boots" over bussing and insulating mats to cover areas of exposed live parts.
- .7 Review with Consultant if any feeder (conductor) is designated for special considerations and if designated as such and is to be interrupted, ensure that at least following preparations are met:
 - .1 Provide schedule of proposed feeders being interrupted. Propose one feeder at a time to be worked on per scheduled shutdown.
 - .2 Provide method of procedure for work.
 - .3 At least 10 working days prior to date of each proposed work, prepare above documentation and submit for Owner approval and Consultant review.
 - .4 On day/night of proposed feeder work, advise Consultant of which feeder is being worked on. Review with Consultant requirements for witnessing work.
 - .5 De-energize feeders and perform work in accordance with Owner approved and Consultant reviewed and recommended for acceptance schedule.
 - .6 After feeders are re-routed, inspect and megger test each feeder.
- .8 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of codes and AHJ.

3.06 GENERAL INSTALLATION REQUIREMENTS

- .1 Unless otherwise noted, comply with manufacturer instructions and recommendations, including product technical bulletins, data sheets and handling, storage and installation instructions. Conform also to Contract Documents and accepted shop drawings.
- .2 Prior to roughing-in of devices and equipment, review final installation locations with Consultant.
- .3 Provide operational equipment and systems in accordance with specified requirements, CSA C22.1, provincial electrical code and product manufacturer instructions, unless otherwise noted.
- .4 Install overhead systems in accordance with CSA C22.3 No. 1 and as noted.
- .5 Install underground systems in accordance with CSA C22.3 No. 7. and as noted.
- .6 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .7 Refer to drawings, details and schedules for additional requirements.
- .8 Install conduits and raceways generally in locations and routes noted, close to building structure. Install minimizing furring requirements and interference with other services or free space. Remove and replace equipment not installed in accordance with Specifications, Drawings or manufacturer recommendations. Install conduits and raceways in concealed spaces, unless otherwise noted.

- .9 Unless otherwise noted, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by area construction. Install services as high as possible to conserve headroom or ceiling space. Prior to installation of Work, notify Consultant where headroom or ceiling space appears to be inadequate.
- .10 Provide additional material for modifications as required to correct minor job conflicts.
- .11 Refer to Architectural drawings for construction details, with regards to roof supports, penetrations through walls, roof and other building construction.
- .12 Unless otherwise noted, connect branch lighting and power circuits to panelboards so as to balance actual loads (wattage) within 5%. If required, transpose branch circuits when work is complete to meet this requirement.
- .13 Consultant reserves right to relocate electrical components such as receptacles, switches, communication system, outlets, hard wired outlet boxes and luminaries from original designed location, but prior to surfaces installations and component installations, without additional cost, and relocation per component does not exceed 3 m from original location.
- .14 For cutting, patching and core drilling work, refer to Section 26 05 05 - Selective Demolition for Electrical.

3.07 SERVICE AND MAINTENANCE ACCOMMODATION

- .1 Install equipment with access and service clearances around equipment, and with space for future equipment removal and replacement. Provide access and service space provisions around equipment in accordance with requirements of AHJ.
- .2 Install equipment and controls, in manner facilitating proper maintenance and ease of repair or replacement.
- .3 Provide adequate clear space for equipment designated as supplied by others and provide connections for such equipment. Prior to commencing work, prepare and submit detailed layouts for review with Consultant.
- .4 Leave clear, spaces reserved for equipment noted as future on drawings, allowing for future connections.

3.08 GROUTING AND LEVELLING

- .1 Equipment with bed plates and flexible or solid couplings: Grout under full area of bedplate, with non-shrinking premixed grout in accordance with applicable requirements of Division 03 or Division 04 and suiting intended applications. After grout sets, remove wedges, shims and jack bolts, and fill spaces with grout.
- .2 Level equipment on rough bases using metal levelling wedges and properly sized pieces of steel plate or steel sections. Maximum allowable grout thickness is 25 mm.

3.09 EQUIPMENT LOADS

- .1 Supply equipment loads (self-weight, operating weight, concrete pad, and inertia pads) 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, confirm equipment loads, location, and method of support prior to fabrication of structural steel. Prior to construction, review locations of equipment with Consultant.

3.10 OPENINGS

- .1 Supply opening sizes and locations to Consultant, allowing 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 review 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, or voids created under scope of work of project, and verify that openings created under scope of work have been closed off, firestopped and smoke-sealed. Unless otherwise directed by Owner and reviewed with Consultant, do not leave any openings unprotected or unfinished overnight.

3.11 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall. Allow minimum 150 mm horizontal clearance between boxes.
- .3 Locate light switches on latch side of doors unless otherwise noted.
- .4 Locate disconnect devices in mechanical and elevator machine rooms on latch side of doors.

3.12 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment or indicated otherwise.
- .2 Before proceeding with installation, where mounting height of equipment is not noted, review with Consultant.
- .3 Install electrical products at following heights unless otherwise noted in accordance with accessibility requirements reviewed with Consultant:
 - .1 Local Switches: 1000 mm (unless otherwise to be in accordance with accessibility requirements of building code).
 - .2 Wall Receptacles:
 - .3 General: 450 mm.
 - .4 Above top of continuous baseboard heater: 200 mm.
 - .5 Above top of counters or counter splash backs: 175 mm.
 - .6 In Mechanical Rooms: 1400 mm.
 - .7 Panelboards: As noted, unless otherwise required by AHJ.
 - .8 Telephone and Interphone Outlets: 450 mm.
 - .9 Wall-mounted telephone and interphone outlets: 1000 mm.
 - .10 Fire Alarm Manual Stations: Between 1050 mm to 1150 mm above floor measured to centre of manual station (unless otherwise to be in accordance with accessibility requirements of building code).
 - .11 Fire Alarm Bells: 2100 mm.
 - .12 Wall-Mounted Fire Alarm Speakers: 2100 mm.
 - .13 Television Outlets: 450 mm or 1800 mm unless otherwise noted.

- .14 Clocks: 2100 mm unless otherwise noted.
- .15 Doorbell Pushbuttons: 1000 mm unless otherwise noted.
- .4 Fire alarm device mounting heights: Also, in accordance with CAN/ULC-S524.
- .5 Barrier free access installation: Refer to drawings for barrier free areas. Install devices at following heights.
- .6 Above mounting heights are typical. Prior to start of Work, review mounting heights with Consultant.

3.13 INSTALLATION OF SLEEVES

- .1 Where conduits, round ducts and conductors pass through structural poured concrete or masonry surfaces, provide sleeves as noted and of type suiting intended applications.
- .2 Prior to pouring of concrete, install sleeves.
- .3 Size sleeves for free passage of conduit, and protruding 50 mm.
- .4 Do not use plastic sleeves in fire-rated walls or floors.
- .5 Submit to concrete reinforcement detailer at proper time, drawings indicating required sleeves, recesses and formed openings in poured concrete work or masonry work. Dimension such drawings and relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.
- .6 Size sleeves to leave 13 mm clearance around conduit, duct, conductor, and other material passing through openings. Pack and seal void between sleeves and conduit, duct, conductors and other material passing through opening, for length of sleeves with specified firestopping and sealing materials, and including.
 - .1 Firestopping and smoke seal materials: Fire-rated construction.
 - .2 Fire-retardant, waterproof non-hardening mastic: Foundation walls and below grade floors.
 - .3 Waterstop plate and synthetic rubber interlocking link type mechanical seals: Waterproof slabs or walls.
 - .4 Acoustic seals for openings: Partitions and floor slabs.
 - .5 Water-tight seals: Exterior walls, or walls in contact with moisture.
 - .6 Synthetic rubber interlocking link type mechanical seals: Sealing pipes through other walls, floors and casings.
- .7 Supply sleeves of water protecting type in following locations:
 - .1 Mechanical and fan room floor slabs, except where on grade.
 - .2 Slabs over mechanical, fan, electrical and telephone equipment rooms or closets.
 - .3 Floors equipped with waterproof membranes.
 - .4 Roof slabs.
 - .5 Waterproof walls.
- .8 Do not provide "Gang" type sleeving.
- .9 Sleeves for exposed work: Terminate both ends of sleeves flush with building surface. Install escutcheon plate to cover sleeve completely, except for sleeves in waterproof floors which are to terminate 100 mm above finished floor.
- .10 Where sleeves are provided in non-fire rated construction for future conduits and ducts, cap and seal both ends of sleeved opening.

- .11 Where conduits or duct are removed from existing sleeves, cap and seal both ends of sleeved opening.
- .12 Coordinate below grade penetrations with waterproofing systems or with damp proofing systems.

3.14 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Where work penetrates or punctures fire-rated construction, coordinate provision of ULC certified, listed and labeled firestopping and smoke sealing packing material systems to seal openings and voids around and within raceway and providing continuity and integrity of fire separation is maintained.
- .2 Refer to Division 07 for additional installation requirements. Coordinate responsibilities of work with general trades.

3.15 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Where work penetrates or punctures fire rated construction, provide firestopping and smoke sealing packing material systems to seal openings and voids around and within raceway and to provide continuity and integrity of fire separation is maintained.
- .2 Install firestopping and smoke seal materials for each installation in accordance with specific ULC certification number and manufacturer instructions. Comply with building code requirements and obtain approvals from AHJ. Verify that openings through fire separations do not exceed maximum size wall opening, and maximum and minimum dimensions in accordance with respective ULC listings.
- .3 Verify that continuity and integrity of fire separation is maintained and conform to respective ULC listings.
- .4 Perform work as follows:
 - .1 In accordance with manufacturer installation instructions for each specific application.
 - .2 Clean areas and surfaces before materials are installed.
 - .3 Examine substrates, openings, voids, adjoining construction and conditions under which firestop and smoke seal system is installed. Verify compatibility of surfaces.
 - .4 Verify penetrating items are securely fixed and properly located with proper space allowance between penetrations and surfaces of openings.
 - .5 Prior to commencement of work, report unsuitable or unsatisfactory conditions to Consultant. Commencement of work means acceptance of conditions and surfaces.
 - .6 Mask where necessary avoiding spillage and over-coating onto adjoining surfaces. Remove stains on adjacent surfaces.
 - .7 Prime substrates.
 - .8 Provide temporary forming and remove only after materials have gained sufficient strength and after initial curing.
 - .9 Tool or trowel exposed surfaces neat, smooth, and with consistent finish.
 - .10 Remove excess compound promptly as work progresses and upon completion.
- .5 When work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies, notify Consultant. Prior to concealing or enclosing work, arrange for final inspection of work by AHJ. Make corrections.

- .6 On completion of firestopping and smoke sealing installation, submit manufacturer technician compliance certificate certifying firestopping and smoke sealing installation has been carried out to service penetrations and that installation has been performed in accordance with requirements of AHJ, ULC requirements and manufacturer instructions.
- .7 Where work requires removal of existing firestopping materials and replacement of firestopping materials after cabling changes have been made, verify that replacement material is same material and manufacturer of existing if any remains in place, or verify that existing material is removed before installation of replacement material.

3.16 INSTALLATION OF BACKBOARDS

- .1 Provide backboards for systems and equipment.
- .2 Securely wall mount each backboard with proper fasteners, suiting wall construction.
- .3 Size backboards to sufficiently provide adequate terminal space for each system, plus 20% space for future additions. Provide back boards of dimensions where identified.

3.17 INSTALLATION OF ESCUTCHEON PLATES

- .1 Provide escutcheon plates suitably secured over exposed conduits passing through finished building surfaces. Finished building surface is surface with factory finish or that receives site applied finish.
- .2 Install one piece escutcheon plates unless piping has already been installed.
- .3 Install plates tight against building surface concerned, completely covering sleeves and openings. Where waterproof sleeves extend above floors, fit plate tightly around sleeve.
- .4 Review finishes with Consultant.
- .5 Unless otherwise noted:
 - .1 Polished stainless-steel plates in finished spaces.
 - .2 Chrome or paint finish on metal plates in unfinished spaces.

3.18 CONCRETE REQUIRED FOR ELECTRICAL INSTALLATION

- .1 Coordinate provision of concrete required for electrical work with Work of Division 03. Coordinate requirements (type, dimensions, re-enforcing, locations).
- .2 Layout and mark out Work as required for installation of concrete necessary for duct banks, equipment pads, bollards, pole bases, and other Work as indicated on drawings.
- .3 Locate pads at site and be present during concrete pour to ensure anchor bolts, inserts, plates and similar hardware are not damaged or dislodged.
- .4 Coordinate pad installations with concrete trade and ensure pads are keyed into structure to meet seismic restraint requirements.

3.19 CONCRETE WORK FOR ELECTRICAL EQUIPMENT PADS

- .1 Provide poured concrete work, including reinforcing and formwork, required for electrical equipment pads.
- .2 Perform concrete work in accordance with requirements of Division 03. Coordinate work with General Trades Contractor.
- .3 Concrete: Minimum 20,700 kPa ready-mix concrete in accordance with CSA A23.1/CSA A23.2 and building code.

- .4 Submit for review, dimensioned shop drawings, prepared and stamped by Structural Professional Engineer registered in jurisdiction of the Work, for concrete pads for support of large heavy equipment. Indicate on shop drawings total weight of pad as well as equipment it is provided for, and concrete reinforcing.
- .5 Verify that pads are keyed into structure in accordance with seismic restraint requirements.

3.20 EQUIPMENT BASES AND SUPPORTS

- .1 Provide equipment bases (pads) and supports. Coordinate concrete pour for pads, luminaire poles bases and bollards with work of Division 03.
- .2 Submit dimensioned shop drawings of structurally designed bases for support of large, heavy equipment. Indicate on shop drawings:
 - .1 Total weight of base, reinforcement, and equipment for which it is required.
 - .2 Templates and anchor bolts for proper setting of equipment on pads.
- .3 Unless otherwise noted, submit detailed design of concrete pads.
- .4 Unless otherwise noted, secure floor-mounted equipment in place on concrete pads as follows:
 - .1 Pads not less than 100 mm high and not less than 100 mm wider and longer than equipment base dimensions.
 - .2 Secure equipment to pads with mounting hardware. Place anchor bolts during concrete pour and level, align and grout equipment.
 - .3 As minimum, use wire mesh reinforcement, however, for pads for large heavy equipment such as gensets and main power transformers, use reinforcement in accordance with structural drawing details.
 - .4 Chamfer edges of pads.
 - .5 In accordance with equipment manufacturer recommendations and special construction requirements when specified by Structural Professional Engineer.
 - .6 With vibration isolation and seismic controls in accordance with respective product Sections or Section 26 05 48 - Vibration and Seismic Control.
- .5 Perform work within formwork Subcontractor schedule.
- .6 Unless otherwise noted, support equipment suspended above floor level with suitable welded or bolted prime coat painted structural steel angles or channels bracketed to wall or secured by hanger rods. Submit details with shop drawing submissions.
- .7 For equipment not designed for concrete base mounting and except those for small equipment, where required provide welded, cleaned and prime coat painted structural steel stands or supports in accordance with following:
 - .1 Designed by Structural Professional Engineer registered in jurisdiction of the Work.
 - .2 Submit stamped and signed design drawings with calculations as shop drawings for review.
 - .3 Provide flange bolt steel stands to concrete pads.
 - .4 Seismically restrained in accordance with AHJ and building code requirements.

3.21 ELECTRICAL SERVICE REQUIREMENTS FOR FLOATING FLOOR SLABS

- .1 Where electrical services are installed in or through vibration isolated floating slab, install such services so as not to transmit any vibration to base slab on which floating floor slab is placed.
- .2 Wherever possible, arrange electrical work avoiding penetrating floating floor slab.

3.22 EXCAVATION AND BACKFILL WORK

- .1 Excavation and backfill work required for electrical work is under work of Division 31, except for final hand grading work and backfill to 450 mm above service which is responsibility of Division 26.
- .2 Mark out location and routing of excavation required for work as well as required depth. Verify bedding is graded, providing proper drainage for ducts as reviewed with Consultant.
- .3 Where inverts and locations of existing site services are site surveyed and locations are indicated, such locations are approximate. Confirm that various utility providers have performed locates and marking out. Prior to commencement of work, verify inverts and locations are correct. Where discrepancies are found, immediately inform Consultant, and await direction.
- .4 Allow Consultant and AHJ to inspect work before covering and backfilling.

3.23 ELEVATOR EQUIPMENT POWER AND CONTROL CONNECTIONS

- .1 Install splitter trough, disconnect switches, outlet boxes, and ancillary devices for elevators provided as part of work of Division 14. Provide additional relays and contacts to interconnect with auxiliary building systems and equipment. Refer to and comply with Division 14 requirements.
- .2 Unless otherwise noted, terminate power and control wiring at elevator controllers for final connection to elevator equipment as part of work of Division 14. Review with elevator trades, extent of work and provide work to interface. Interconnections and provisions are required to following:
 - .1 Power for elevators.
 - .2 Power for cab interior devices.
 - .3 Telephone and other communications for cab.
 - .4 Signalling and fire alarm interconnections for initiating sequence of operation of elevators (such as homing). Provide fire fighters key switch control for takeover of elevators.
 - .5 Telephone and miscellaneous power in elevator machine room.
 - .6 Smoke and heat detection products in elevator room and elevator pit.
 - .7 Other items coordinated and reviewed with elevator trades.
- .3 Provide central control and interlocking feeders for elevator equipment noted on drawings.
- .4 Prior to roughing-in, coordinate requirements with elevator equipment supplier and installer.
- .5 Identify each disconnect switch with labels and lettering in accordance with Division 14.
- .6 Provide GFCI type 120 V convenience outlets in elevator machine rooms and pits.
- .7 Provide empty conduit with fish cords, from telephone head end equipment to elevator machine room for future wiring and connection by Division 14 to each elevator cab phone. Terminate on box outside elevator controller.

- .8 Provide fire alarm system provisions as specified in Section 28 46 00 - Multiplex Fire Alarm and Voice Communication Systems and as specified in Division 14.
- .9 Comply with applicable requirements of ASME A17.1/CSA B44 and CSA B44.1/ASME A17.5. Coordinate with Division 14 in obtaining required inspection and compliance certificates.

3.24 ELECTRIC MOTORS, MOTOR CONTROLLERS, CONTROLS AND ELECTRICAL CONNECTIONS

- .1 Coordinate responsibilities related to supply, installation, testing and verification of motors, motor control equipment (starters, motor control centres, variable frequency drives) and controls.
- .2 Control Wiring and Conduit: In accordance with Section 26 05 21 - Low Voltage Conductors and Cables, except for wiring and connections below 50 V which are related to control systems specified in Division 25.
- .3 Provide electrical connections to equipment including equipment supplied by other Divisions. Review shop drawings and coordinate with each equipment vendor, requirements for power feeds, control and communication interconnections, and provide these requirements to complete installations work.
- .4 Review drawings and schedules. Provide wired and empty conduit systems with fish cord, junction boxes, pull boxes, outlet boxes, faceplates and sleeves. Provide interconnect wiring between remote operator devices, controllers, and equipment being controlled by operator devices. Where equipment is of split-unit design and line voltage is required to both units, provide feeders to each unit as coordinated with equipment manufacturer.
- .5 Provide complete wired and empty conduit systems with fish cord, junction boxes, pull boxes, outlet boxes, faceplates, sleeves and ancillary devices. Provide disconnect switches, receptacles and other wiring and connection accessories. Coordinate work with respective Consultants and suppliers of equipment to be provided with electrical connections.
- .6 Provide lugs, terminals, and screws used for termination of wiring that are suitable for type of conductors and equipment connected.
- .7 Refer to Divisions 10 and 11 and include for coordination and interconnections of Divisions 10 and 11 requirements and equipment schedules.
- .8 Mechanical Division supplied fire pumps and sprinkler pump controllers, and transfer switches: Provide power and control wiring in conduit from emergency power plant (gensets) to equipment. For specific AHJ applications, provide ULC listed and labeled 2-hour fire rated type conductors. Control wiring between genset control panel and respective equipment to supply signal of start-up of gensets (start of emergency power sequence) and signalling loss of normal power at equipment. Coordinate requirements with Mechanical Divisions.
- .9 Coordinate alarm connections of equipment with Mechanical Divisions BAS Contractor. Refer to drawings of both Electrical Divisions and Mechanical Divisions for BAS points to be connected. Include for wiring in conduit, contacts, termination/junction boxes and ancillary devices as required for interconnection.

- .10 Coordinate with Mechanical Division 23, supply and installation of motor control centres (MCCs), motor starters, variable frequency drives (VFDs) (also known as variable speed drives –VSDs) and harmonic filters for motorized equipment supplied by Mechanical Divisions. Motor starters, MCCs and VFDs are generally as scheduled and in accordance with respective product Sections. Generally, starters are supplied in following manner:
 - .1 Loose starters for mounting adjacent to apparatus or on motor starter panels.
 - .2 Mounted starters in factory assembled and pre-wired motor control centres.
 - .3 Mounted starters on factory assembled and pre-wired packaged equipment.
- .11 Provide following work as coordinated with Mechanical Division work:
 - .1 Mount loose starters and provide line and load power connections.
 - .2 Mount motor starter panels with conduit work at motor starter panels installed level, plumb and aligned with building surfaces. Plan installation to avoid crossovers.
 - .3 Make line side power connections to motor control equipment and load side connections to motors or other apparatus supplied power from motor control equipment.
 - .4 Make line side power connections to starters on packaged equipment.
 - .5 Install disconnect switches in accordance with Section 26 28 23 - Disconnect Switches – Fused and Unfused.
 - .6 Make connections to thermistors and provision of additional relays as required for connections to starters.
 - .7 Perform motor starter interlocking in accordance with motor control equipment and starter schedules. Coordinate interlocking requirements with work of Division 23.
 - .8 In coordination with work of Division 23, provide 120 VAC power feeds to receptacles and luminaires integral with mechanical equipment including air handling units.
 - .9 Provide identification nameplate on each motor control equipment, VFD, motor starter or disconnect. Nameplates identify equipment identification number and electrical ratings.
 - .10 Connect VFDs and harmonic filters with power, control and monitoring conductors in accordance with manufacturer instructions and electrical code. Make interlock connections between disconnect switch and VFD to signal VFD to turn off when disconnect switch is opened. Provide manufacturer recommended conductors and connectors suiting respective connected equipment. Provide required upstream fused disconnects or breakers and overload protection. Maintain separation of power and control conductors in accordance with manufacturer requirements to minimize effects of electromagnetic interference. Ground and bond equipment.
 - .11 Perform other items as noted.

3.25 PROVISIONS FOR BUILDING AUTOMATION SYSTEMS

- .1 Display points and functions of electrical distribution system equipment and other systems on BAS as specified and as scheduled. Provide digital type and analogue communications points, as noted and suiting intended applications.

- .2 Provide wiring, conduit and connections from respective equipment and extend to load side of terminal cabinet. Provide line side wiring, conduit and connections of terminal cabinet and extend to BAS connection points and panels, as coordinated with BAS vendor.
- .3 For potential indications, provide fused disconnect and potential transformer, rated 600/120 V, connected to centre phase.
- .4 Terminal Cabinet:
 - .1 NEMA 1 unless otherwise noted, CSA certified.
 - .2 Surface mounted with hinged door and drip shield.
 - .3 Screw type indexed terminals.
 - .4 Suitable size and labeled with lamacoid nameplate, identifying use, equipment designated number and electrical characteristics.
 - .5 Factory finished painted.
 - .6 Nameplate nomenclature and finishes: Reviewed with Consultant.
- .5 Analogue indications: Provide two minimum #12 AWG conductor and #12 AWG ground conductor in 20 mm conduit for each function to respective terminal cabinet.
- .6 Digital functions: Provide communications and control wiring of type reviewed with respective connected equipment vendors and run in 20 mm conduit for each function to respective terminal cabinet.
- .7 Install terminal cabinets with tops not to exceed 1800 mm above finished floor. Determine quantity of cabinets based on BAS circuits in common areas located in same cabinet.
- .8 Coordinate requirements with BAS vendor. Refer to Division 25 for additional requirements.

3.26 PATHWAYS FOR VARIOUS SYSTEMS

- .1 Provide systems of conduits, raceways, electrical boxes and pull wires, for systems.
- .2 Provide following basic electrical components accommodating installation of various miscellaneous systems:
 - .1 Conduit:
 - .1 Diameters as sized on drawings with non-metallic fish wires or pull cords and suitable bushings for conduit terminations.
 - .2 In accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings, and respective system trade Sections.
 - .3 Labelling at each end to clearly identify each conduit run with respect to system and path.
 - .2 Outlet Boxes:
 - .1 Size and type suiting intended applications.
 - .2 Complete with faceplates or coverplates.
 - .3 In accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings and respective system trade Sections.
 - .3 Pull Boxes, Junction Boxes and Back Boxes:
 - .1 Size and type suiting intended applications.
 - .2 Complete with coverplates.
 - .3 In accordance with Section 26 05 31 - Splitters and Electrical Boxes and respective system trade Sections.

- .4 Sleeves:
 - .1 Size and type suiting intended applications.
 - .2 Refer to sleeve requirements of this Section.
- .3 Miscellaneous systems are noted on drawings. Provide dedicated conduit runs for each system. Coordinate sizes of boxes with respective system vendors, providing sizing accommodating components and wiring-bending radii. Review conduit and box requirements with system vendors.
- .4 Provide pull boxes in conduit runs longer than 30 m or having more than two 90° bends. Size pull box in accordance with respective system standards, but no shorter in length of at least 8 times diameter of entering conduit.
- .5 Leave conduits free and clear of obstructions and terminate. Equip terminations with bushings and clearly identify each run. Provide fish wires in empty conduits. Run telecommunications conduits with separation from sources of electromagnetic radiation in accordance with ANSI/TIA-569-E. Site bend telecommunications conduit elbows in accordance with system conduit bending radii requirements.
- .6 Prior to roughing-in, review requirements and locations of equipment with Consultant and respective system installers.
- .7 Refer to system riser diagrams on drawings.
- .8 Determine quantities for outlets in accordance with floor plan drawings and not riser diagrams.

3.27 PROVISIONS FOR DOOR HARDWARE

- .1 Coordinate supply and installation of door alarm contacts, door holders, electric strikes, electromagnetic locks, door operator controls, power supplies, door controllers, central electromagnetic lock release controller and other door hardware, with respective trades.
- .2 Review product voltage and wiring requirements, back box requirements and wiring installation requirements with door hardware trades and with equipment vendors. Provide wiring in conduit from each device to respective controllers, between each device, and to central control panel and for power connection to such controls and devices. Provide line level voltage power feeds to equipment.
- .3 Controls and Interconnections Between Devices: Supply and run interconnecting wiring in conduit to devices and allow spare length of 1.8 m coiled wiring at each end for final termination to devices.
- .4 Applications of Electro-Magnetically Held Closed Doors: Engage fire alarm system vendor to provide fire alarm type manual station with auxiliary contacts for interconnection of electro-magnetic door hardware and fire alarm system, for release of doors. Provide wiring in conduit and connections. Review manual station requirements with fire alarm system vendor.
- .5 Review type of door alarm contacts with door construction and finishes. Provide recessed mounted contacts and install wiring in concealed conduits. Review requirements with door hardware and security vendor.
- .6 Where controls are located remotely from door locations, such as in closets, provide wiring in conduit and extend from secured side above door, junction boxes and devices, with homeruns back to closet location of equipment and leave slack wiring for terminations. Review requirements with door hardware and security vendor and review with Consultant.

- .7 Submit detailed responsibility matrix identifying work and responsibilities of each trade and required interconnections.
- .8 Refer to respective trades Sections for additional requirements.

3.28 PROVISIONS FOR FURNITURE SYSTEMS

- .1 Provide rough-in for electrical devices including but not limited to:
 - .1 Outlets.
 - .2 Switches.
 - .3 Thermostats.
 - .4 Other control devices.
 - .5 Fire alarm devices.
 - .6 Clocks and communications devices.
- .2 Locate avoiding wall mounted systems furniture wall strips. Relocate conduit and devices which do not coordinate with systems furniture requirements identified on systems furniture drawings.
- .3 Coordinate location of electrical conduits or ducts within floor slabs and mounted to underside of floor slabs, with location of free-standing work stations and furniture systems.
- .4 Install power conductors to wall or ceiling mounted junction box and extended out to furniture system, through empty conduit, raceways, and back boxes provided within furniture system.
- .5 Branch circuit conductors in furniture system raceways may be AC-90 flexible armoured conductors.
- .6 Run telecommunication (data/voice) conductors as complete home runs from LAN closet to work station outlet.
- .7 Testing and verification of furniture system devices is responsibility Electrical Division.
- .8 Where furniture systems are not supplied with pre-wired devices, supply and install devices. Wire and connect complete.
- .9 Confirm exact requirements with furniture system trades.

3.29 PRODUCT REQUIREMENTS IN SPECIAL AREAS

- .1 Special areas include such areas as:
 - .1 Correctional institutions.
 - .2 Mental health.
 - .3 Children care.
 - .4 Public vehicle parking.
 - .5 Non-climate controlled public.
- .2 Provide special areas with provisions such that intended users of area are not exposed to or subject to hazards from supplied products. Provide products manufactured for use in such environments.
- .3 Power receptacles, switches and communication devices features:
 - .1 Resistance to tampering: Tamperproof screws.
 - .2 Resistance to vandalism and impact:

- .1 Heavy duty construction.
- .2 Polycarbonate covers or wire guards.
- .3 Non-climate-controlled areas: Weather-resistant provisions such as gasketed covers, corrosion resistant hardware and weather-resistant finishes. Devices operate in extreme temperatures.

3.30 CLEANING

- .1 Progress Cleaning: Leave Work area clean at end of each day.
- .2 Final Cleaning:
 - .1 Work performed in electrical equipment rooms, electrical closets and communication closets, perform following:
 - .1 Prior to energization, HEPA vacuum and clean interiors and buswork of switchgear, switchboards, panels, cabinets and other electrical equipment, of construction debris and dust.
 - .2 HEPA vacuum top of switchgear, switchboards, panels, cabinets, bus ducts, cable trays and conduits in room, followed by thorough HEPA vacuuming of floors.
 - .3 Prior to final turn over: Coordinate laying of permanent floor matting in electrical rooms after rooms are re-cleaned, and floors wet mopped and dried.
 - .4 Clean luminaire reflectors, lenses, and other luminary surfaces that have been exposed to construction dust and dirt, including top surface, whether it is exposed or in ceiling space.
 - .5 Clean switches, receptacles, communications outlets, cover plates, and exposed surfaces.
 - .6 Clean other electrical equipment and devices.
 - .2 Refer to individual sections for additional specific cleaning instructions.

3.31 SCAFFOLDING, HOISTING, AND RIGGING

- .1 Unless otherwise noted, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner and review with Consultant. Coordinate responsibilities and work with general trades.
- .2 Include scaffolds in manner with as little as possible interference to work of other trades.
- .3 Do not place major scaffolding or hoisting equipment loads on any portion of structure without approval from Owner and review with Consultant. Do not weld, bolt or otherwise affix supports, clips, brackets or similar devices to finished members or surfaces without approval from Owner and review with Consultant.
- .4 Immediately remove from site, scaffolding, rigging and hoisting equipment when no longer required.

3.32 PROTECTION

- .1 Protect equipment and materials onsite from damage and defacement due to elements and work of trades. Upon Substantial Performance of the Work, provide equipment and materials in new condition.
- .2 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

- .3 Protect personnel on job site from injury due to live equipment and circuits.
- .4 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician.
- .5 Protect concrete floors and finished flooring from damage. Provide additional measures when moving heavy loads or equipment.
- .6 Keep floors free from oils, grease or other materials likely to discolour them or affect bond of applied surfaces.
- .7 Attach and fasten fixtures and fittings in place in safe, sturdy, secure manner so that they cannot work loose, fall or shift out of position during normal use of building.
- .8 Protect finished and unfinished work from damage due to carrying out of this work.
- .9 Make good damages caused directly or indirectly by work to walls, floors, ceilings, woodwork, masonry, finishes, structures and existing installations.
- .10 After products are installed and tested, protect products from dirt, dust and moisture until building is ready for turnover and service, unless otherwise noted.
- .11 Protect existing areas above, below and adjacent areas of Work from debris, noise, or interruptions to existing services in accordance with requirements of Owner and as specified. Maintain in operation existing services to these areas, allowing Owner continued use of these areas. Where services that are required to be maintained run through areas of renovations, provide protection to services or reroute, in coordination with Owner and review with Consultant.

3.33 FINISH PAINTING OF ELECTRICAL WORK

- .1 Unless otherwise noted, finish painting of exposed Electrical Divisions work is responsibility under work of Division 09.
- .2 Coordinate provision of identification painting for electrical distribution equipment in accordance with application requirements of Division 09. Review exact finish colours with Consultant. Equipment requiring special colour identification painting to include but not be limited to following:
 - .1 Pull boxes and junction boxes.
 - .2 Communication system conduit.
 - .3 Genset exhaust piping.
- .3 Spray painting is not permitted unless approved by Owner and reviewed with and recommended for acceptance by Consultant.

3.34 COMMISSIONING

- .1 The commissioning agent will be an approved vendor under the Richmond Hill roster and will be handled under the cash allowance.

Approved Vendors

 - .1 C.E.S Engineering Ltd.
 - .2 Pact Engineering Inc.
- .2 Interface, cooperate and coordinate with Commissioning Agent and attend commissioning meetings. Perform commissioning activities for aspects of work provided in Electrical Divisions and perform corrective work identified by Commissioning Agent.

- .3 After successful start-up and prior to Substantial Performance of the Work, commission electrical work. Demonstrate to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that equipment, systems and subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents.
- .4 Verify modes and sequences of control and monitoring, interlocks, and responses to emergency conditions. Complete commissioning data sheets to document successful operational performance testing.
- .5 Make submittals such as O & M manuals, shop drawings, schedules and test reports of systems and equipment to Commissioning Agent, prior to start of commissioning activity or as directed by Commissioning Agent.
- .6 Commissioning Agent may also be present for any testing or commissioning activities. Notify Commissioning Agent in advance of these activities.
- .7 Coordinate work with Field Quality Control work.
- .8 Refer to Division 01 for additional commissioning requirements.
- .9 Refer to Section 26 08 00 - Commissioning of Electrical Systems for additional requirements.

3.35 NOTICE FOR REQUIRED FIELD REVIEWS

- .1 Whenever there is requirement for Consultant to perform field review prior to concealment of any work, to inspect/re-inspect work, give minimum 7 working days' notice in writing to Consultant.
- .2 If Consultant is unable to attend field review when requested, arrange alternative date and time.
- .3 Do not conceal work until Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

3.36 MAINTENANCE TO EQUIPMENT PRIOR TO ACCEPTANCE

- .1 Provide maintenance to equipment in accordance with manufacturer instructions prior to start-up, testing and commissioning.
- .2 Check rechargeable batteries, storage capacitors and similar products to determine if installation and energizing onsite is in accordance with manufacturer instructions to maintain warranty and service life. Replace products as required.
- .3 Filters to be new upon Substantial Performance of the Work. This is in addition to spare filters.

3.37 PRELIMINARY TESTING

- .1 When directed by Consultant, arrange, pay for and perform site tests on equipment or systems for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and AHJ requirements.
- .2 When, in Consultant opinion, tests are required to be performed by 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 or workmanship of any kind.
- .4 When, in Consultant opinion, tests indicate that equipment or products are defective or deficient, immediately remove such equipment or products from site and replace them with acceptable equipment or products, at no additional cost.

3.38 FIELD QUALITY CONTROL

- .1 Unless otherwise noted, provide minimum 10 working days advance notice to Consultant of inspection, testing or verification work.
- .2 After completion of installation, perform inspection, start-up, testing and verification work in accordance with requirements of following:
 - .1 As specified in respective Sections.
 - .2 Section 26 05 70 - Electrical Testing.
 - .3 Manufacturer instructions and recommendations.
 - .4 Commissioning Agent and commissioning sections.
- .3 Perform field quality control work in addition to requirements of standard factory testing of products as specified in respective Sections. Submit specified factory testing reports with shop drawings.
- .4 Product Manufacturer Instructions and Recommendations:
 - .1 Submit product manufacturer instruction procedures and recommendations for product onsite start-up, testing and verification.
 - .2 Include performance standards for verification, testing parameters, pass/fail or go/no-go standards.
- .5 Engage respective systems or equipment vendors or trades to be onsite during field quality control work to perform adjustments or remedial work to correct issues identified by field quality control work.
- .6 Manufacturer Certified Technician Field Quality Control Work:
 - .1 Onsite services as applicable to respective products as specified in Sections include providing basic requirements as follows:
 - .1 Visual Inspection:
 - .1 Ensure that shipping members have been removed.
 - .2 Ensure that interiors are free of foreign materials, tools and dirt.
 - .3 Check for damage (dents, scratches, frame misalignment, damage to devices).
 - .4 Check doors for proper alignment and operation.
 - .2 Mechanical Inspection:
 - .1 Check power wiring connections for tightness.
 - .2 Check control wiring connections for tightness.
 - .3 Electrical Inspection:
 - .1 Check input for proper voltage.
 - .2 Check output for proper voltage.
 - .4 Startup and Basic Commissioning:

- .1 Startup of equipment and systems, installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .2 Energize units and perform manufacturer recommended start-up and commissioning procedures.
- .5 Instructions: Instruct operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Services provided for such period, and for as many onsite visits as necessary to put equipment in operation and train operating personnel on aspects of operation and maintenance.
- .3 Signed report or compliance certificate supplied verifying compliance of Work in performance, handling, installing, applying, protecting and cleaning of products. Submitting reports as noted.
- .4 Product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer instructions.
- .5 Initial inspection, start-up, programming, testing and verification work.
- .6 Assistance to installers with specific instructions on installation of equipment and systems.
- .7 Assistance during independent testing in accordance with Section 26 05 70 - Electrical Testing.
- .8 Instructions to end users on operating and maintenance of equipment and systems.
- .9 Coordination of and directing adjustments to and remedial of work in accordance with performance requirements, test and verification report results and testing and verification report comments.
- .10 Assistance in integrations between systems and equipment.
- .7 Onsite Inspection, Start-up, Testing, Commissioning and Verification Work:
 - .1 Prepare proposed schedule for onsite testing and verification work and submit to Consultant for review and recommendation for acceptance. Notify Consultant in writing at least 10 working days in advance of testing and verification work, unless otherwise noted.
 - .2 Inspect and test products for proper operation and performance meeting requirements of Specification, AHJ, Consultant and Commissioning Agent. Where testing procedures conflict, review with Consultant prior to proceeding with Work and obtain direction.
 - .3 Refer to Section 26 05 70 - Electrical Testing for additional testing requirements.
 - .4 Where noted or required by AHJ, perform integrated systems testing in accordance with CAN/ULC-S1001. Coordinate Work with other Divisions.
 - .5 Verify operations and performance.
 - .6 Perform manufacturers start-up and basic commissioning procedures.
 - .7 Perform testing and verification work in presence of Consultant and Commissioning Agent. Commissioning Agent and Consultant to have option to attend and witness testing. Review and coordinate administration.
 - .8 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of phase of project (as applicable) and project.
 - .9 Unless otherwise noted, perform testing as non-destructive.
- .8 Remedial Work:

- .1 Adjust and provide corrective work meeting performance requirements and in accordance with requirements as outlined in testing and verification reports.
- .2 Rectify deficiencies and malfunctioning equipment.
- .3 Remove and replace equipment that cannot be repaired.
- .4 Re-test and verify corrected work.
- .5 Test and verify replacement products and work.
- .9 Reports:
 - .1 Prepare testing and verification reports, documenting results, observations and recommendations, signed by testing technician and witnesses.
 - .2 Where specified, submit reports stamped and signed by Professional Engineer.
 - .3 Submitted with product manufacturer report where required.
 - .4 Submitted with compliance certificates where required.
 - .5 Unless otherwise noted, submit electronic pdf versions to Consultant.

3.39 TRAINING AND DEMONSTRATION

- .1 Responsibility: Systems and equipment manufacturer authorized representative.
- .2 Submit for review with Consultant:
 - .1 Proposed list of systems and equipment for training and demonstration.
 - .2 Proposed schedule of demonstration and training dates and times.
 - .3 Proposed use of equipment and systems for training and demonstration purposes.
- .3 Provide onsite sessions to train and demonstrate to end user designated personnel, aspects of operation and maintenance of equipment and systems. Unless otherwise noted, supply printed copies and electronic copies of training materials to each attendee. Obtain from Owner, list of Owner representatives to receive instructions.
- .4 System/Equipment: Number of sessions and durations:
 - .1 Exterior lighting control (if applicable) – (1) session
- .5 Provide dedicated separate sessions for each system, each with instruction duration time requirements to complexity of each system. 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 and audio-visual aids during training sessions. Supply required labour, material, and instruments.
- .6 Training modules consist of:
 - .1 Operational Requirements and Criteria: Equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations.
 - .2 Troubleshooting: Diagnostic instructions, testing and inspection procedures.
 - .3 Documentation: Equipment/system warranties, and manufacturer parts and service facilities, telephone numbers, email addresses and web sites.
 - .4 Maintenance: Inspection instructions, types of cleaning agents used as well as cleaning methods, preventive maintenance procedures and use of special tools.
 - .5 Repairs: Diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components and review of spare parts inventory.

- .6 Other items as noted in Specification and items recommended by respective equipment manufacturers.
- .7 After training is completed, submit to Consultant, list of systems for which instructions were given, stating for each system:
 - .1 Date instructions were given to Owner staff.
 - .2 Duration of instruction.
 - .3 Names of persons instructed.
 - .4 Other parties present.
- .8 Obtain signatures of attendees to verify their attendance at these sessions and have received O&M instruction manuals.
- .9 Maintain record of training including:
 - .1 Topics covered.
 - .2 Dates and durations of sessions.
 - .3 List of attendees.
- .10 Submit to Consultant copy of electronic version of training materials loaded on USB flash drive. Include in operating and maintenance manuals submission.

3.40 VIDEO AND AUDIO RECORDINGS

- .1 Provide and edit professional quality custom colour digital video and audio recording of instruction training and demonstrating sessions for following:
 - .1 Emergency power gensets and control systems.
 - .2 Fire alarm systems.
 - .3 Security systems.
 - .4 Intercommunication systems.
 - .5 Lighting control and dimming systems.
 - .6 Other systems as specifically noted in trades sections.
- .2 Produce custom video in format that includes following:
 - .1 Professional videographer onsite capturing training session. Use of wireless lavalier microphone capturing audio of trainer in association with video footage. Edit video to remove unnecessary footage.
 - .2 Custom site-specific system or equipment screens outlining key information about system or equipment and devices used onsite only.
 - .3 Custom site-specific video detailing programming procedures in conjunction with voiceover from on-site technician.
 - .4 Main menu screen and authored with chapters allowing operator access to specific areas of training instantly.
- .3 Submit electronic versions of videos to Consultant.

3.41 SEMI-FINAL AND FINAL INSPECTIONS

- .1 Perform semi-final and final inspections with Consultant. Review scheduling requirements with Consultant and obtain Consultant recommendations for acceptance.
- .2 Semi-Final Inspections:

- .1 Prior to semi-final inspection, submit list of items which are either not finished or deficient at time of semi-final inspection.
- .2 Verify following items prior to semi-final inspection. Provide declaration in writing that following items listed are completed:
 - .1 Systems capable of operation with controls functional and automatic controls generally in operation.
 - .2 Tests on equipment and systems made including tests required by AHJ.
 - .3 Equipment and system set-up and start-up procedures completed in accordance with manufacturer data.
 - .4 Equipment and system testing and identification completed.
 - .5 Warranty forms completed and registered with manufacturer. Include copies of original warranties with O & M manuals.
 - .6 Sample of O & M manuals submitted. Operating and maintenance instructions, and schedule submitted for Consultant review.
 - .7 Access doors inspected and verified in suitable location for easy access to equipment requiring maintenance and servicing.
 - .8 Equipment is located easily accessible for maintenance and servicing.
 - .9 Noise and vibration control devices and flexible connections inspected by manufacturer representative and report submitted.
- .3 Final Inspections:
 - .1 Submit to Consultant written request for final inspection of systems. Include written certification that:
 - .1 Deficiencies noted during job inspections and semi-final 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 Final calibration of controls completed.
 - .5 Maintenance and operating data have been completed and submitted to, reviewed with Consultant and accepted.
 - .6 Nameplates and labels are in place and equipment identifications have been completed.
 - .7 Clean-up is complete. Equipment cleaned inside, outside and lubricated.
 - .8 Spare parts and replacement parts specified have been provided, as reviewed with Consultant.
 - .9 As-built and record drawings have been completed and submitted to and reviewed with Consultant and recommended for acceptance.
 - .10 End users have been instructed in operation and maintenance of systems.
 - .11 Commissioning procedures have been completed and recommended for acceptance.
 - .12 AHJ has accepted installations.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 National Research Council Canada (NRC):
 - .1 National Building Code of Canada (NBC), [2020].
 - .2 National Fire Code of Canada (NFC), [2020].
- .2 Ontario Building Code (OBC), [2024 with amendments].

1.02 SUBMITTALS

- .1 Submit copies of compliance certificates.

1.03 REGULATORY REQUIREMENTS

- .1 Obtain required permits and inspections. Give required notices. Include copies of permits and inspection certificates with operation and maintenance manuals.
- .2 Perform work in accordance with following:
 - .1 NBC.
 - .2 NFC.
 - .3 OBC.
 - .4 Government of Canada, Labour Program: Workplace Safety.
 - .5 Ministry of the Environment, Conservation and Parks, governing waste management.
 - .6 Ministry of Labour.
 - .7 AHJ.

2. Products

2.01 MATERIALS

- .1 Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section. Provide new materials to meet assembly or system characteristics as existing systems indicated to remain and carry CSA certification labels.
- .2 Firestopping Repair Materials:
 - .1 Use firestopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire-rated performance.

3. Execution

3.01 EXAMINATION AND SITE CONDITIONS

- .1 Discovery of Hazardous Substances: Refer to requirements in Section 26 00 10 - Electrical Work General Instructions.

- .2 Refer to Section 02 41 19 - Selective Demolition for additional requirements.

3.02 SALVAGE AND DEBRIS MATERIALS

- .1 Review with Consultant existing items designated as salvage, designated as reused or designated to be turned over to party designated by Consultant.
- .1 Remove from site, existing materials that are disconnected and designated as obsolete or to be removed. Review such materials with Consultant. Transport materials being retained, to storage area designated by Consultant.
- .2 Coordinate performance of following with other trades:
 - .1 Removal from site and proper dispose of materials which are removed and are not designated for re-use in the Work.
 - .2 Removal of materials and items designated for salvage and storage in manner to prevent damage or devaluation of materials in accordance with Section 02 41 17 - Disassembly Removal and Storage.

3.03 PREPARATION FOR DEMOLITION WORK

- .1 Coordinate performance of following with other trades:
 - .1 Scheduling: Account for continued occupancy requirements during selective demolition in accordance with Section 02 41 19 - Selective Demolition.
 - .2 Verifying that prior to start of demolition work, affected building areas are unoccupied and discontinued in use and that required screens, partitions, hoardings are in place.
 - .3 Prior to start of Work, verifying that existing services in areas affected by demolition are disconnected, capped, made safe or removed as reviewed with Consultant.
 - .4 Prior to start of Work, notifying Consultant and onsite personnel of demolition work that may cause safety risks.
 - .5 Coordinating electrical disconnections of electrically powered mechanical equipment and making safe electrical services with work of Divisions 21, 22, 23 and 25.
- .2 During course of work, where asbestos-containing materials or other hazardous substances are encountered or suspected, cease work in area in question and immediately notify Consultant. Comply with requirements of AHJ. Do not resume work in affected area without direction from Consultant.

3.04 PROTECTION

- .1 Take steps to positively prevent uncontrolled falling of demolished materials.
- .2 Verify that no part of existing structure is over-loaded due to work carried out under Work.
- .3 Prevent debris from blocking surface drainage systems, elevators, mechanical and electrical systems that remain in operation. Provide temporary guards and hoardings during and until completion of work.
- .4 Coordinate performance of following with other trades:
 - .1 Provision and maintenance of barricades, guards, railings, lighting, warning signs, security personnel and other safety measures for protection for workers and public during execution of the Work. Where demolition is proceeding, close off access to area to unauthorized personnel.

- .2 Provision of temporary bracing, shoring and supports as specified in Section 02 41 17 - Selective Structural Dismantling and Demolition and 02 03 46 - Shoring and Temporary Support.

3.05 ELECTRICAL DISCONNECTIONS AND REMOVALS

- .1 Examine and familiarise with existing systems and installations and other conditions affecting the Work.
- .2 Refer to applicable drawings which define extent of areas being demolished in existing building. Review drawings and site and demolition and renovation of services as required to accommodate alterations detailed.
- .3 Provide electricians licensed in place of Work to perform electrical disconnections. As required, disconnect electrical system circuits and feeders at power source.
- .4 Maintain in operation, existing installations retained in and around areas being renovated, maintaining operating conditions as follows:
 - .1 Without restrictions on Owner hours of work and access to areas as reviewed with Consultant.
 - .2 No disruptions to operations in adjoining and other areas. Provide required temporary bypass installations and removed after permanent installations/changes are complete.
 - .3 When respective work is deleted, such deletions are to in no way affect operation of existing interconnected mechanical or electrical components that remain. When existing circuits are being disconnected, maintain supervision of area such that circuits do not affect existing circuits being retained.
 - .4 Where existing services pass through or are in area to serve items which are to remain, or pass through areas being deleted, maintain services but reroute as required. Reroute existing services concealed behind existing finishes and which become exposed during renovation work and conceal behind new or existing finishes. Review with Consultant services being kept in service and operational.
 - .5 Protect existing electrical services including power, and existing life safety systems against damage during entire construction period.
 - .6 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of codes and AHJ.
- .5 Where noted on drawings or where required to perform Work of this Project, disconnect and remove items of existing obsolete electrical work or designated for removal.
- .6 Where noted, re-install existing electrical work being retained that was removed as part of demolition work.
- .7 Where noted, disconnect and remove existing fire alarm system including associated conduits, boxes, wiring, and similar items.
- .8 Where noted, disconnect and remove communication systems including associated conduits, boxes, cabling, and similar items.
- .9 Where noted, disconnect and remove telephone outlets, associated conduit, cabling and sub-terminal backboards and related accessories. Maintain telephone service and main terminal backboard as is, unless otherwise noted.

- .10 Relocate devices accommodating work of other Divisions. Where luminaires, switches, receptacles, and other devices and equipment are removed, disconnect at point of electrical supply, remove obsolete wiring and conduit up to source and make safe. Remove obsolete conduit/raceways in accessible ceiling spaces, exposed locations, and other noted locations. Where existing obsolete conduit and similar raceway material cannot be removed, such as embedded in concrete, cut back and cap obsolete conduit and raceways, unless otherwise noted.
- .11 When relocating luminaires, inspect luminaire for circuit identification and identify circuiting on as-builts if circuiting is maintained. Prior to relocating luminaires, remove lamps, glass and lenses and inspect for damages and deficiencies. Clean luminaires including lenses prior to installation. Advise Consultant of deficiencies and await directions.
- .12 Disconnect electrical circuits and panel feeders. Maintain electrical service and main distribution panel as is, ready for subsequent Work. Where breakers are no longer circuited, rename as 'SPARE', until re-used.
- .13 Provide revised panelboard directories or identification nameplates, when affected by renovation, disconnection, or removal of work. Use actual room names/numbers, as applicable.
- .14 Protect existing devices being relocated, preventing damage to devices. Test such devices prior to disconnection and de-energization, verifying that each device is in working condition. Examine and test that motors are in proper rotation direction. Prior to initiating work, report devices not working or with damage, to Consultant.
- .15 Provide junction boxes, outlet boxes, wiring, plates and conduits, as necessary for complete relocation of devices. Before being reinstalled, clean relocated or temporary removed devices and equipment and test verifying that they are in good operating condition. Splice conductors only with Consultant review and recommendation, and with provision of junction boxes and terminal devices for proper extension of circuits. Otherwise, replace circuits with continuous homeruns extending from devices to circuit panel. Provide access panels suiting intended applications and luminaire locations in ceilings inaccessible.
- .16 Provide blank cover plates on existing obsolete boxes which remain in position, as reviewed with Consultant. Provide weather-resistant covers for boxes in non-climate-controlled areas.
- .17 After installation is complete, test parts of re-used or relocated electrical equipment for proper operation and correct faults and grounds. For fire alarm work, engage existing fire alarm system manufacturer to verify relocated devices and remaining devices on either side of removed or relocated devices on same circuit, and test and verify system suiting relocation work. For other existing systems, engage manufacturer authorized representative or existing system maintenance contractor as reviewed with Consultant, to inspect, test and verify relocated devices. Perform testing and documenting to similar standards specified for new Work. Document testing in test reports, signed by testing technician. Review requirements with Consultant. Submit reports to Consultant.
- .18 Maintain in operation, interior, exterior or underground electrical services (including auxiliary services, telephone, fire alarm, P.A. and other communications systems) to operating parts of building. Maintain existing risers in service as required to feed other areas of building or other building as applicable. Do not interrupt services without review with Consultant and prior written recommendations or instructions from Consultant. Submit formal requests to Consultant, outlining in detail, requirements of proposal.

- .19 Where references are made on drawings that existing receptacles and other wiring devices be extended and relocated to suit new construction, test devices and when found defective replace with new devices. Test and verify operation of replacement devices. Replace cracked or broken cover plates with plate finishes reviewed with Consultant.
- .20 Disconnect power supply to branch circuits controlling lighting, receptacles, panels and mechanical equipment, for safe removal of equipment, conduit, wiring and boxes, affected by demolition.
- .21 Close openings in and around boxes, panels, fixtures and devices, that result from their removal. Close openings with patching suitable for application and terminate and insulate cables to restore system to safe operating condition.
- .22 Disconnect and remove electrical equipment, luminaires, communication devices, and other system components, during demolition of ceilings, walls, floors and structures. Temporarily relocate until demolition work is completed, existing equipment not relocated but interferes with demolition. Maintain in operation services to temporarily relocated equipment. Test and verify operation of equipment and devices temporarily relocated.
- .23 Remove underground cables designated as deleted and cut back conduit systems to depth of 600 mm below finished grade and abandoned in place. Grind off conduits and make flush with surface of concrete where conduits are cast into concrete. Seal open ends of conduit with silicone sealant and leave in place.
- .24 Check transformers designated for deletion, for PCB materials. Decommission, disconnect and remove transformers and PCB wastes offsite. Refer to requirements of Section 26 05 90 - Hazardous Materials.
- .25 Decommission, disconnect and transport transformers designated for deletion and not containing PCBs, off site or salvaged or transported to storage sites as reviewed with Consultant.
- .26 Handle and dispose of PCB and mercury materials in accordance with Division 02 and AHJ.

3.06 PAINTING RESTORATION WORK

- .1 Coordinate provision of painting and restoration work with work of Division 09.
- .2 Provide painting to match existing finishes as reviewed with Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 ASTM International (ASTM):
 - .1 ASTM B779-[18], Standard Specification for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors, Steel-Reinforced (ACSR/TW).
- .2 CSA Group (CSA):
 - .1 CSA-C22.2 No. 131-[17], Type TECK 90 Cable.
 - .2 CSA C68.5-[20], Primary Shielded and Concentric Neutral Cable for Distribution Utilities.
 - .3 CSA C68.10-[20], Shielded Power Cable for Commercial and Industrial Applications, 5-46 kV.
 - .4 CAN/CSA-C61089-[11(R2020)], Round Wire Concentric Lay Overhead Electrical Stranded Conductors.
- .3 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE 48-[2020], IEEE Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit plans of proposed changes in cable routing.
- .4 Submit proposed cable splicing plans.
- .5 Submit testing and verification reports.

2. Products

2.01 GENERAL

- .1 Unless otherwise noted, provide each cable continuous with no splices. Refer to additional requirements in Part 3.
- .2 Where under jurisdiction of electrical utility, verify with electrical utility that cable provided is acceptable for connection to utility electrical system.

- .3 Selected shielded cables to safely withstand ground fault current without damage for 8 cycles with available shield fault of 20,000 amperes. Calculate to confirm current rating using manufacturer design calculations and standards, and revise withstand rating as necessary. Notify Consultant of changes.
- .4 Ratings, number of and sizing of conductors: Identified on drawings and schedules, unless otherwise noted.
- .5 Use copper conductors only, unless otherwise noted. Use of aluminum conductors is subject to review with and recommendation for acceptance by Consultant.

2.02 PRIMARY OVERHEAD CONDUCTORS (1001 - 15000 V)

- .1 Insulated Copper Conductors: For up to 5 kV, with 5 kV polyethylene insulation.
- .2 Bare aluminum conductors steel reinforced, as follows:
 - .1 In accordance with authority having jurisdiction requirements for respective voltage rating.
 - .2 In accordance with CAN/CSA-C61089 and ASTM B779.
 - .3 Concentric-lay-stranded conductor consisting of stranded steel central core with one or more layers of trapezoidal shaped stranded aluminum wires.
 - .4 Steel core wires protected from corrosion by galvanizing, aluminum-clad alloy or zinc (5% aluminum metal alloy coating).
 - .5 With supporting hardware, insulators and ancillary devices.
- .3 Pole Line Hardware: Heavy duty, hot dipped galvanized steel and manufactured to CSA standards for pole line hardware.
- .4 Lightning arrestors and fused assemblies: Suited intended applications.

2.03 ALUMINUM SHEATHED CABLES (1001 - 5000 V)

- .1 Conductors: Copper.
- .2 Insulation: Cross-linked polyethylene, Type RA90 rated 5 kV.
- .3 Sheath: Seamless, corrugated or smooth, aluminum.
- .4 Outer Covering: Extruded PVC.

2.04 SHIELDED POWER CABLES (1001 - 15000 V)

- .1 In accordance with CSA C68.5.
- .2 Conductors: Copper.
- .3 Conductor Shield: Semiconducting crosslinked polyolefin.
- .4 Insulation: 100%, tree-retardant crosslinked polyethylene rated 105°C.
- .5 Insulation Shielding: Strippable semiconducting crosslinked polyolefin.
- .6 Cable Jacket: Thermosetting with separator tape between shield and jacket. Jacket colour is manufacturer standard colour.
- .7 Lead free and Restriction of Hazardous Substances (RoHS) compliant.
- .8 Terminators: Cold shrink type terminators suited intended application. Refer to cable termination article in this Section.

2.05 CONCENTRIC NEUTRAL POWER CABLE (1001 - 15000 V)

- .1 In accordance with CSA C68.5.
- .2 Conductor: Single copper.
- .3 Stranding: Compact round.
- .4 Conductor Shield: Extruded semi-conducting crosslinked polyolefin.
- .5 Insulation: 100% insulation level; tree-retardant cross-linked polyethylene, rated 90°C.
- .6 Insulation Shield: Semi-conducting crosslinked polyolefin.
- .7 Concentric Neutral: Helically wound tinned copper conductors.
- .8 Copper neutral wires applied helically over insulation shield.
- .9 Extruded PVC or polyethylene outer jacket rated minus 40°C. Jacket colour is manufacturer standard colour.
- .10 Lead free and Restriction of Hazardous Substances (RoHS) compliant.
- .11 Terminators: Cold shrink type terminators suiting intended application. Refer to cable termination article in this Section.

2.06 TECK POWER CABLE (1001 - 15000 V)

- .1 Cable up to 5 kV: In accordance with CSA-C22.2 No. 131.
- .2 Cable 8 kV and Greater: In accordance with CSA C68.10.
- .3 Bare copper grounding conductor.
- .4 Copper circuit conductors.
- .5 Strand shielding.
- .6 Insulation: Cross-linked thermosetting polyethylene rated RW90.
- .7 Insulation Shielding: Semi-conducting non-metallic tape over insulation and served wire shield over tape.
- .8 Separator tape over conductor assembly.
- .9 Inner jacket of PVC.
- .10 Interlocked aluminum armour.
- .11 Overall PVC jacket rated minus 40°C.

2.07 HIGH VOLTAGE CABLE TERMINATIONS

- .1 Cold shrink, silicone rubber termination kits as follows:
 - .1 CSA certified.
 - .2 In accordance with IEEE 48 with voltage ratings of 5, 8.7, 15, 25/28 or 34.5 kV suiting intended applications.
 - .3 Maximum continuous operating temperature rating of 105°C, with emergency overload rating of 140°C.
 - .4 Pre-stretched cold shrink design with removable core. When core removed, product shrinks to provide tight seal, without application of heat source.
 - .5 Capacitive termination stress control constructed of stress control compound and EPDM rubber tube.

- .6 Termination insulator of skirted or tubular design, constructed of tracking resistant silicone rubber with enhanced water repelling action. Skirted for outdoor applications.
- .7 Accommodates jacketed concentric neutral, concentric neutral or tape shield cables.
- .8 Compression lugs of type compatible with cable type and vinyl electrical tape.
- .2 Provide termination type in accordance with termination manufacturer recommendations to match (or exceeding where applicable) cable properties including following:
 - .1 Voltage class rating and insulation basic impulse level (BIL) level.
 - .2 Conductor material, conductor size and cable/shielding type.
 - .3 Indoor or outdoor application.

2.08 HIGH VOLTAGE CABLE SPLICES

- .1 Provide splice type in accordance with cable manufacturer recommendations, matching (or exceeding where applicable) cable properties of cable requiring splicing, including following:
 - .1 Voltage class rating and insulation basic impulse level (BIL) level.
 - .2 Conductor material, conductor size and cable/shielding type.
 - .3 Indoor or outdoor application.
- .2 Typical product subject to approval by cable manufacturer of cable being spliced is cold shrink silicone rubber in-line splice kits as follows:
 - .1 CSA certified.
 - .2 In accordance with IEEE 48 with voltage ratings of 5, 8.7, 15, 25/28 or 34.5 kV.
 - .3 Maximum continuous operating temperature rating of 105°C, with emergency overload rating of 140°C.
 - .4 Pre-stretched cold shrink design with removable core. When core removed, product shrinks to provide tight seal, without application of heat source.
 - .5 Capacitive termination stress control constructed of stress control compound and EPDM rubber tube.
 - .6 Termination insulator of skirted or tubular design, constructed of tracking resistant silicone rubber with enhanced water repelling action. Skirted for outdoor applications.
 - .7 Accommodates jacketed concentric neutral, concentric neutral or tape shield cables.
 - .8 Compression lugs of type compatible with cable type and vinyl electrical tape.

2.09 ACCEPTABLE PRODUCT MANUFACTURERS/VENDORS/CONTRACTORS

- .1 High Voltage Cables:
 - .1 Nexans.
 - .2 Prysmian Cables (Pirelli).
 - .3 General Cable.
 - .4 Aetna Cables.
 - .5 Kerite Company.
 - .6 Texcan.

- .2 High Voltage Contractors:
 - .1 Ainsworth Power Systems Group.
 - .2 K-Line Maintenance & Construction.
 - .3 Black and McDonald.
 - .4 PBW High Voltage.

3. Execution

3.01 PROJECT CONDITIONS

- .1 Verify that field measurements and conditions are as noted.
- .2 Cable routing on drawings is schematic and approximate and not reflective of elevations. Route cable suiting project conditions. Determine exact routing and lengths onsite.
- .3 Review fire protection ratings of construction to identify rooms and paths of conductors that are fire-rated. Where fire-rated conductors are required as noted, provide fire-rated conductors where rooms and paths are not fire-rated.

3.02 CO-ORDINATION

- .1 Co-ordinate work with work provided under other electrical work and work of other trades.
- .2 Determine separation between cable and other work.
- .3 Determine cable routing to avoid interference with other work.
- .4 Prior to proceeding with work, if alternative cable routing is proposed, submit proposed alternative cable routing to Consultant for review and recommendations of acceptance.

3.03 GENERAL CABLE INSTALLATION

- .1 Install cable in ducts, maintenance holes, pits, vaults, rooms or on pole lines as noted.
- .2 Perform installation and termination work in accordance with manufacturer instructions.
- .3 Unless otherwise noted, install underground cables in ducts. Prior to insertion of cable in duct, clean duct by pulling mandrel through entire length. Provide pulling lubricant when pulling cables through duct.
- .4 Install cable in trenches, as noted. Refer to Section 26 05 43 - Installation of Cables in Trenches and in Ducts.
- .5 Where cables are run in cable tray or using cable racks, provide cable tray or rack and hardware, and secure to wall/ceiling structure. Provide ancillary mounting hardware securing installations.
- .6 Determine cable lengths using field measurements where possible. Run cable continuous with no splicing.
- .7 Provide cable support and pullbox in conduit runs, where required.
- .8 Construct overhead conductor lines in accordance with requirements of authority having jurisdiction.

- .9 When handling cable on reels, prevent damage during uncoiling process. While cable is being pulled, inspect sheath for visible cracks or other damage. Immediately stop pulling cables when damage is evident and replace or repair cable immediately. When pulling, except for short runs, use pulling eye attached directly to conductors that make up cable. Use CSA certified cable lubricants. When pulling cable, apply pulling tension to conductor not to sheath of cable. Perform cable pulling with tension as recommended by cable manufacturer. Seal cable ends preventing entrance of moisture.
- .10 Terminate cable in equipment with lugs and termination kits, suiting intended application and matching connection provisions of connected equipment. Install stress cones and terminations. Prepare cable for accommodating termination. Install lugs using matching size die and crimping tool.
- .11 Provide separate grounding conductors. Ground shielding at each termination, unless otherwise noted.
- .12 Provide cable identification tags and identify each phase conductor of power cable. Identify exposed cable with orange colour tape bands every 3 m.

3.04 INSTALLATION OF CABLE SPLICES

- .1 Prior to start of work, review use of splicing of cables and locations of splices with Consultant and obtain recommendations for acceptance from Consultant.
- .2 Where use of splices is recommended for acceptance by Consultant, locate splices in accessible area. Identify locations of splices on drawings.
- .3 Locate damaged section of cable. Perform excavation work and shoring.
- .4 Provide cable manufacturer recommended cable splicing kit to splice cable to cable. Install splice kits. Prepare cable for accommodating splice jacketing tubes and body. Provide suitable splice box.
- .5 Prepare splices watertight and mark and identify spliced section of cabling. Install lugs using matching size die and crimping tool. After installation is completed and inspected, test splice.

3.05 FIELD QUALITY CONTROL

- .1 Before putting cables into service, test cables and terminations. Do not exceed manufacturer recommended test voltage or duration.
- .2 Verify that insulation resistance is in accordance with cable manufacturer acceptable limits.
- .3 Use tradespersons experienced and licensed for installation, splicing, termination and testing of cables.
- .4 Obtain compliance certificates of work. Submit with reports.
- .5 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 35-[20], Extra-Low-Voltage Control Circuit Cable, Low-Energy Control Cable, and Extra-Low-Voltage Control Cable.
 - .2 CSA C22.2 No. 38-[18], Thermoset-insulated Wires and Cables (Trinational Standard with UL 44 and ANCE NMJ-J-451).
 - .3 CSA C22.2 No. 51-[20], Armoured Cables.
 - .4 CSA C22.2 No. 123-[16(R2021)], Metal Sheathed Cables.
 - .5 CSA C22.2 No. 124-[16(R2021)], Mineral-Insulated Cable.
 - .6 CSA C22.2 No. 127-[18], Equipment and Lead Wires.
 - .7 CSA C22.2 No. 129-[10(2019)], Neutral-Supported Cables.
 - .8 CSA C22.2 No. 131-[17], Type TECK 90 Cable.
 - .9 C22.2 No. 174-18 (R2022), Cables and Cable Glands For Use in Hazardous Locations.
 - .10 CSA C22.2 No. 208-18, Fire Alarm and Signal Cable.
 - .11 CSA C22.2 No. 214-[17], Communications Cables (Bi-National Standard, with UL 444).
- .2 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S139-[2017-REV2], Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 For fire-rated type RC90 and type FAS 105 cables, identify ULC tested rating designations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports.

2. Products

2.01 GENERAL BUILDING WIRES

- .1 CSA certified, or ULC labeled and certified.
- .2 Ratings, number of conductors and sizing of conductors: As noted.

- .3 Conductors constructed of 98% conductive copper and certified for minimum 600 V volts, unless otherwise noted.
- .4 Solid conductors to and including No. 10 AWG; stranded conductors in sizes larger than No. 10 AWG.
- .5 RW90 XLPE:
 - .1 In accordance with CSA C22.2 No. 38.
 - .2 Single copper conductor, [600 V] [1000 V], maximum 90°C conductor temperature, minus 40°C minimum installation temperature.
 - .3 X-link polyethylene (XLPE) insulation, colour coded.
- .6 T90 Nylon:
 - .1 In accordance with CSA C22.2 No. 75.
 - .2 Single copper conductor, 600 V, maximum 90°C dry conductor temperature, minus 10°C minimum installation temperature.
 - .3 PVC insulated, nylon covered.
- .7 RWU90 XLPE:
 - .1 In accordance with CSA C22.2 No. 38.
 - .2 Single copper conductor, [600 V] [1000 V], maximum 90°C conductor temperature, minus 40°C minimum installation temperature.
 - .3 Extra thickness X-link polyethylene (XLPE) insulation suitable for wet and buried installations, colour coded.
- .8 TWU:
 - .1 In accordance with CSA C22.2 No. 75.
 - .2 Single copper conductor, 600 V, maximum 60°C conductor temperature, minus 40°C minimum installation temperature.
 - .3 PVC insulated suitable for wet and buried installations, colour coded.
- .9 AC90:
 - .1 In accordance with CSA C22.2 No. 51.
 - .2 Flexible armoured cable with RW90 copper conductors and bare copper ground conductor.
 - .3 Overall interlocked aluminium tape armour.
 - .4 Anti-short bushing connectors.
- .10 AC90 ISO-BX:
 - .1 In accordance with CSA C22.2 No. 51.
 - .2 Flexible armoured cable with RW90 conductors.
 - .3 Low temperature high density polyethylene (HDPE) copolymer insulation and two additional solid copper bonding conductors (one bare, one insulated).
 - .4 Overall interlocked aluminium tape armour..
- .11 RA90:
 - .1 In accordance with CSA C22.2 No. 123.
 - .2 Single or multi copper conductors, suitable for 600 V service.
 - .3 Cross-linked polyethylene insulation, FT4 and 90°C rated.
 - .4 Enclosed by continuous extruded corrugated aluminum sheath.

- .5 Overall PVC jacket.
- .6 For exposed and concealed wiring in dry or wet locations or where exposed to weather.
- .12 Flexible Armoured Cable Fittings:
 - .1 Saddle type, constructed of malleable iron/steel, electro-zinc plated inside and outside.
 - .2 With nylon-insulated throat or anti-short bushing to suit specific applications.
- .13 Optionally, conductors of amperage rating exceeding 150 A or rating specifically as noted, may be aluminum alloy conductors of series AA-8000 grade. Provide connectors and associated hardware compatible to and marked for connection to aluminum alloy conductors in accordance with aluminum wiring manufacturer recommendations and as required by electrical code. Install aluminum alloy conductors with hardware and connectors in accordance with conductor manufacturer instructions and requirements of electrical code. Resize conductors and conduits from copper-based sizing, maintaining ampacity ratings indicated, in compliance with electrical code.

2.02 TECK 90 CABLE

- .1 In accordance with CSA C22.2 No. 131.
- .2 Rated for outdoor, weather-resistant and wet locations including direct burial applications.
- .3 1000 V rated.
- .4 Conductor: Bare, soft drawn, Class B compact or compressed stranded copper conductors.
- .5 Insulation: Chemically cross-linked thermosetting polyethylene (XLPE).
- .6 Bonding Conductor (1/C Cable): Soft drawn bare copper.
- .7 Inner Jacket: Sunlight resistant PVC jacket tightly applied over assembly, to prevent slipping of core in a vertical position.
- .8 Armour: Flexible interlocked aluminum armour, over inner jacket for mechanical protection.
- .9 Overall PVC jacket rated minus 40°C.
- .10 Barrier tape over shield.
- .11 Terminations to suit specific applications and approved for TECK cable.
- .12 Fastenings:
 - .1 One-hole steel straps to secure surface cables 50 mm and smaller. Two-hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables.
 - .3 Threaded Rods: Not less than 6 mm diameter to support suspended channels.

2.03 MINERAL-INSULATED CABLES (MI)

- .1 Fire Rated Fire Alarm and Voice Communication MI Cable:
 - .1 CSA certified as FAS, FAS 90 and FAS 105 cable.
 - .2 ULC Listed 2-hour fire-resistive cable tested in accordance with CAN/ULC-S139 fire test standards.

- .3 Conductors: Twisted pair, solid bare soft-annealed copper, No. 18 AWG or No. 16 AWG, as reviewed with Consultant.
 - .4 Maximum Continuous Operating Temperature: 90°C.
 - .5 Maximum Exposure Temperature: 1010°C.
 - .6 Insulation: Compressed powdered magnesium oxide or silicon dioxide to form compact homogeneous mass throughout entire length of cable.
 - .7 Outer Covering: Annealed seamless copper sheath, type MI rated 300 V, 250°C.
 - .8 Overall Jacket: Polymer-low-smoke, zero halogen.
 - .9 Connectors: Factory installed and tested or field installed and certified for MI cable.
 - .10 Termination Kits: Factory installed or field installed and certified for MI cable.
 - .11 Galvanized steel C-channel supports, cable clips and straps as recommended by cable manufacturer suiting intended application. In applications of dissimilar materials, provide tape to insulate cabling and hardware.
 - .12 Brass plates for cable openings in ferrous metal enclosures.
 - .13 Cable manufacturer ancillary accessories and identification labelling.
 - .14 Manufacturer Technician Services:
 - .1 Providing onsite initial coordination with installing personnel in reviewing installation of cabling runs and termination of cabling.
 - .2 Inspecting installation and performing testing of cable.
- .2 Fire Rated 600 V Power MI Cables:
- .1 In accordance with CSA C22.2 No. 124.
 - .2 ULC listed and labeled two-hour fire-resistive cable tested in accordance with CAN/ULC-S139 fire test standards.
 - .3 Conductors: Solid bare soft-annealed copper.
 - .4 Maximum Continuous Operating Temperature: 90°C.
 - .5 Maximum Exposure Temperature: 1010°C.
 - .6 Insulation: Compressed powdered magnesium oxide or silicon dioxide to form compact homogeneous mass throughout entire length of cable.
 - .7 Outer Covering: Annealed seamless copper sheath, type MI rated 600 V, 250°C.
 - .8 Overall jacket for wet locations and non-climate-controlled areas installation: PVC applied over sheath and compliant to applicable building code classification.
 - .9 Connectors: Factory installed and tested or field installed and certified for MI cable.
 - .10 Termination Kits: Factory installed or field installed and certified for MI cable.
 - .11 Galvanized steel C-channel supports, cable clips and straps as recommended by cable manufacturer, suiting intended application. In applications of dissimilar materials, provide tape to insulate cabling and hardware.
 - .12 Brass plates for cable openings in ferrous metal enclosures.
 - .13 Cable manufacturer ancillary accessories and identification labelling.
 - .14 Manufacturer Technician Services:
 - .1 Providing onsite initial coordination with installing personnel in reviewing installation of cabling runs and termination of cabling.
 - .2 Inspecting installation and performing testing of cable.

2.04

FIRE RATED TYPE RC90 CABLES

- .1 Type RC90, self-contained fire-rated power cable system as follows:
 - .1 Cable manufacturer approved and recommended complete package of cables, fittings, connectors, clamps, securing hardware, electrical boxes and other installation components, tested by UL/ULC as packaged system.
 - .2 2-hour fire-rated and wet location rating, 600 V, 90°C.
 - .3 CSA listed as Type RC90 in accordance with CSA C22.2 No. 123.
 - .4 Certified in accordance with CAN/ULC-S139 Electrical Circuit Integrity System #120 (FHIT7), for each conductor size used. Exact ULC tested rating designations confirmed with cable manufacturer for intended specific applications.
 - .5 Installed in accordance with manufacturer instructions and qualification criteria of ULC standards.
 - .6 Single Conductor Cable: Stranded annealed copper conductor covered with LSZH ceramifiable silicon insulation and overall continuously welded and corrugated copper armour.
 - .7 Multi-conductor Cable: Stranded annealed copper conductors covered with inner jacket of ceramifiable silicon rubber bedding layer and overall continuously welded and corrugated copper armour.
 - .8 Where use is approved by AHJ.
- .2 Include connectors, cable clips, straps, identification labeling and ancillary materials as recommended by cable manufacturer to suit specific installation applications. Provide support spacing not exceeding manufacturer instructions, suiting intended applications.
- .3 Include for manufacturer authorized technician to perform initial coordination with and providing training to installing personnel on installation and termination of cabling runs. After completion of Work, manufacturer technician to review installation work, test cabling and terminations and provide formal report of test results with observations, and certification that installation work is complete, and cabling and terminations perform as required, in accordance with cable manufacturer and specified requirements.

2.05 FIRE RATED TYPE FAS 105 CABLES

- .1 Type FAS 105 circuit integrity fire-rated communication cable system as follows:
 - .1 Cable manufacturer approved and recommended complete package of cables, fittings, connectors, clamps, securing hardware, EMT conduits, electrical boxes and other installation components, tested by UL/ULC as packaged system.
 - .2 Two hour fire-rated and wet location rating, 300 V, 105°C.
 - .3 CSA listed as type FAS 105 and in accordance with CSA C22.2 No. 208.
 - .4 Certified in accordance with CAN/ULC-S139 Electrical Circuit Integrity System 40A (FHIT7), for each conductor size used. Exact ULC tested rating designations confirmed with cable manufacturer for intended specific applications.
 - .5 Installed in accordance with manufacturer instructions and qualification criteria of ULC standards.
 - .6 Two Conductor Cable: Solid annealed copper conductor covered with LSZH silicon rubber insulation, copper/polyester tape shield and overall outer jacket of LSZH polyolefin construction.
 - .7 Where use is approved by AHJ.

- .2 Include connectors, cable clips, straps, identification labeling and ancillary materials as recommended by cable manufacturer to suit specific installation applications. Provide support spacing not exceeding manufacturer instructions, suiting intended applications.
- .3 Include for manufacturer authorized technician to perform initial coordination with and providing training to installing personnel on installation and termination of cabling runs. After completion of Work, manufacturer technician to review installation work, test cabling and terminations and provide formal report of test results with observations, and certification that installation work is complete, and cabling and terminations perform as required, in accordance with cable manufacturer and specified requirements.

2.06 CONTROL CABLES

- .1 Type LVT 30 V Shielded Control Cable:
 - .1 In accordance with CSA C22.2 No. 35, FT4 rated.
 - .2 Applications: Extra-low-voltage circuits.
 - .3 Conductors: Soft annealed solid copper conductors, sized suiting intended applications, unless otherwise noted.
 - .4 Insulation: Type TW - PVC thermoplastic.
 - .5 Shielding: Paramagnetic foil tape.
 - .6 Overall Covering: PVC jackets.
 - .7 Sheath and jacket for applications requiring additional protection: PVC thermoplastic jacket with armour of closely wound aluminum wire.
 - .8 Temperature Rating: Minus 20°C to 60°C.
 - .9 Where installed in plenums, cable certified to C22.2 No. 214 and FT6 rated.
- .2 Type LVT 300 V Shielded Control Cable:
 - .1 In accordance with CSA C22.2 No. 35, FT4 rated.
 - .2 Applications: Low voltage circuits.
 - .3 Conductors: Solid annealed solid copper conductors sized suiting intended applications, unless otherwise noted.
 - .4 Insulation: Polyethylene.
 - .5 Shielding: Paramagnetic foil tape.
 - .6 Overall Covering: PVC jackets.
 - .7 Sheath and jacket for applications requiring additional protection: PVC thermoplastic jacket with armour of closely wound aluminum wire.
 - .8 Temperature Range: Minus 20°C to 80°C.
 - .9 Where installed in plenums, cable certified to CSA C22.2 No. 214 and FT6 rated.
- .3 Type TEW:
 - .1 In accordance with CSA C22.2 No. 127.
 - .2 Solid bare copper conductor, rated for 600 volts, No. 18 AWG.
 - .3 Thermoplastic insulated with nylon overall jacket.
 - .4 105°C conductor temperature.
 - .5 With required number of copper conductors and colour coding, suiting intended applications.
- .4 Provide other types of control wiring reviewed with respective equipment manufacturer requirements and in accordance with applicable local electrical code requirements.

2.07 CABLE FOR VARIABLE FREQUENCY DRIVES

- .1 In accordance with CSA C22.2 No. 123 and CSA C22.2 No. 174.
- .2 Flame, oil and UV resistant cable with copper conductors, corrugated continuous aluminum sheath and bonding conductors.
- .3 Impact and crush-resistant.
- .4 Lead free and RoHS compliant.
- .5 Temperature Rating: 90°C to minus 40°C.
- .6 1000 V 90°C rated cross link polyethylene insulation.
- .7 FT4 PVC jacket.
- .8 As recommended by connected variable frequency drive manufacturer.
- .9 Connectors: In accordance with cable manufacturer recommendations.

2.08 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Low Voltage Cables:
 - .1 Nexans.
 - .2 Prysmian Cables (Pirelli).
 - .3 General Cable.
 - .4 Aetna Cables.
 - .5 Kerite Company.
 - .6 Texcan.
- .2 MI Cable:
 - .1 nVent - Pyrotenax.
- .3 Fire- Rated Cable (Alternative to MI):
 - .1 Marmon (VITALink).

3. Execution

3.01 PROJECT CONDITIONS

- .1 Verify that field measurements and conditions are as noted.
- .2 Cable routing on drawings is schematic and approximate and not reflective of elevations. Route cable, meeting project conditions. Determine exact routing and lengths onsite.
- .3 Review fire protection ratings of construction to identify rooms and paths of conductors that are fire-rated. Where fire-rated conductors are required as noted, provide fire-rated conductors where rooms and paths are not fire-rated.

3.02 CO-ORDINATION

- .1 Co-ordinate work with work provided under other electrical work and work of other trades.
- .2 Coordinate and maintain separation between cable and other work.
- .3 Determine cable routing avoiding interference with other work.

3.03 GENERAL CABLE INSTALLATION

- .1 Install and terminate cables.
- .2 Install and pull cables in accordance with cable manufacturer requirements for bending radii and pulling tensions.
- .3 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .4 Conductor length identical for parallel feeders.
- .5 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .6 Wiring in Walls: Drop or loop vertically from above to better facilitate future renovations. Avoid wiring from below and horizontal wiring in walls.
- .7 Provide branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment as 2-wire circuits only. Common neutrals not permitted.
- .8 Conductor Types and Sizes: As noted on drawings and in accordance with electrical code. Increase where required, suiting length of run and voltage drop. Includes conductors not sized or specified of type. Where conductor sizing schedule is issued with Contract Documents, size in accordance with schedule.
- .9 Ground cabling in accordance with cable manufacturer instructions and governing electrical code requirements.
- .10 Take precautions when handling cable on reel ensuring that no damage results in uncoiling process.
- .11 Where cables penetrate fire-rated construction, provide ULC listed and labeled, fire stopping and smoke seal materials or fittings to protect integrity of fire-rated construction in accordance with ULC standards. Refer to requirements of Division 07.
- .12 Splicing of existing conductors is allowed only for following conditions, but must be reviewed and recommended for acceptance by Consultant before splicing can proceed:
 - .1 Splicing to extend existing conductors.
 - .2 Low voltage control and signal conductors: Splicing made within electrical box with terminal strips.
 - .3 Interior line voltage conductors: Splicing made within electrical box with cold shrink splice kits and mechanical compression connectors. Full assembly, suiting type and size of conductors and as reviewed with Consultant.
 - .4 Exterior line voltage conductors: Splicing made with outdoor weatherproof cold shrink splice kits and mechanical compression connectors. Full assembly, suiting type and size of conductors and as reviewed with Consultant.
 - .5 Splice and splice box approved by cable manufacturer.
 - .6 Splice and splice box identified with identification painting or labeling.
 - .7 Splice and splice box clearly identified on as-built drawings.
 - .8 Use of split bolts is not permitted.

3.04 INSTALLATION OF CONDUCTORS

- .1 Provide fire-rated conductors for applications as required by building code and authority having jurisdiction.

- .2 Typically, install wiring in conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .3 Install conductors, unless otherwise noted as follows:
 - .1 Residential Feeders: NMD90.
 - .2 Underground inside or outside building and for non-climate-controlled areas: TWU or RWU90.
 - .3 Connections to electric heating coils in supply air ductwork systems, and for connections to other electric heating equipment where use of 90°C rated conductors are recommended by heating equipment manufacturer: RW90.
 - .4 Conductors requiring fire-rating by building code and authority having jurisdiction, including feeders for emergency systems, fire fighter elevators, fire alarm systems, other life safety systems and for applicable signal and control circuits of these systems: type MI, fire rated, copper sheathed mineral insulated copper conductors.
 - .5 Climate controlled areas branch circuit wiring in accessible ceiling spaces and within stud wall construction consisting of drops down to luminaries and drops down stud walls to devices and in furniture systems: AC90 flexible armoured cable (BX) with maximum 6 m run permitted.
 - .6 Connections to variable speed drives: Cable type as specified and specifically for variable frequency drives as recommended by drive manufacturers.
 - .7 Temporary power connections and similar applications as reviewed with Consultant: DLO type cables.
 - .8 For climate-controlled areas wiring except as noted above or specified elsewhere in Specification or as noted: T90 Nylon or RW90.
- .4 In applications where, multiple conductors in conduit are being run, provide trapeze configuration of metal C-channels and threaded rod hangers to support cable/conduit from ceiling slab. Wall-mounted cable/conduit brackets and ring type conduit hangers may be permitted in applications approved by Owner and reviewed with Consultant. Provide required cable support system accessories for proper installation.
- .5 Support flexible armoured cable in ceiling spaces or in stud wall construction with steel 2 holes cable straps. Run flexible armoured cables in parallel to building lines. Utilize centralized conduit runs to maintain maximum permitted runs of flexible armoured cables. Provide insulating grommet at cut ends of flexible armoured cable to protect conductor insulation. Provide saddle termination connectors at boxes.
- .6 Provide fire-rated type cabling for specific conductors as noted and as required for specific applications by local governing codes. Install fire-rated type conductors in accordance with manufacturer instructions and recommendations. Arrange for manufacturer technician to provide onsite services as specified.
- .7 Install control wiring as follows:
 - .1 Review type of control wiring with manufacturers of equipment and systems being interconnected.
 - .2 Provide cables for fire alarm system applications and security system applications as recommended by respective system manufacturer and complying with requirements of electrical code.
 - .3 Run control wiring in conduit or raceways.
 - .4 Provide conductors not installed in conduit or raceways, with fire-insulated rating in accordance with building code flame spread ratings.

- .5 Mechanically protect cable by means reviewed with and recommended by Consultant.
- .6 Provide conductors with fire-ratings (FT6 rating) requirements when run in plenums and similar construction.
- .7 Coordinate responsibility for provision of control wiring for mechanical equipment and equipment of other Divisions.
- .8 When installing type NMD90 conductors through metal studs, provide insulating grommets on stud openings to protect conductor insulation.
- .9 Do not use conductors smaller than No. 12 AWG in systems over 30 volts, except where otherwise noted. Do not use conductors smaller than No. 6 AWG for exterior luminaire wiring, unless otherwise noted.
- .10 General Cable Colour Coding: In accordance with Section 26 05 53 - Signage and Identification – Electrical.
- .11 Colour code conductors throughout to identify phases, neutrals and ground by means of self-laminating coloured tape, coloured conductor insulation, or properly secured coloured plastic discs. Colours, unless otherwise noted, to be as follows:
 - .1 Phase A – red.
 - .2 Phase B – black.
 - .3 Phase C – blue.
 - .4 Ground – green.
 - .5 Neutral – white.
 - .6 Control – orange.
- .12 When pulling wires into conduit use lubricant and ensure that wires are kept straight and are not twisted or abraded.
- .13 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.
- .14 Number control conductors with push-on PVC Z type markers.
- .15 Colour code conductors for communications systems in accordance with system component manufacturer recommendations.
- .16 Neatly secure exposed wire in apparatus enclosures with approved supports or ties.
- .17 Installation of aluminum conductors:
 - .1 Comply with electrical code requirements and conductor termination manufacturer recommendations when terminating, connecting and supporting aluminium conductors.
 - .2 Be aware of compatibility issues between connecting materials.
 - .3 Coordinate with manufacturers of equipment that conductors are being terminated to and provide terminations, fittings, connectors, joint compound and Bellville type conical washers, suiting application.
 - .4 As required by electrical codes, verify that equipment connected with aluminum conductors are specifically approved for purpose and are so marked.

3.05 INSTALLATION OF TECK 90 CABLE (0-1000 V)

- .1 Provide Tech 90 cables for applications as noted. Handle, install, and terminate in accordance with manufacturer recommendations and instructions and as specified.

- .2 Group cables wherever possible on channels.
- .3 Install cable exposed or concealed suiting intended area of installation. Securely support with straps and hangers.
- .4 When pulling cable, apply pulling tension to conductor not to sheath of cable. Limit cable pulling tension as recommended by cable manufacturer.
- .5 Terminate cable in equipment with lugs and termination kits.
- .6 Ground shielding.
- .7 Splices not permitted except where justified by cable pulling tension calculations and reviewed with and recommended for acceptance by Consultant. Where splices are recommended by Consultant, locate in accessible area. Identify locations on as-built drawings.

3.06 INSTALLATION OF MINERAL-INSULATED CABLES

- .1 Obtain installation and testing training from cable manufacturer. Install cable and terminate.
- .2 Submit with shop drawings, copy of manufacturer detailed installation manual and testing procedures. Provide MI fire-rated type cables for applications:
 - .1 Where noted.
 - .2 Life safety as required by building codes.
 - .3 Required by AHJ.
- .3 Install cable exposed or concealed, suiting intended area of installation.
- .4 Provide metal C-channels, clips and wall brackets as recommended by cable manufacturer, suiting onsite installation conditions. Provide system of C-channel hangers and rods spaced at minimum 1 m as confirmed with cable manufacturer, for running of cables. Where clips and other hardware are in contact with cables, insulate cables/hardware with suitable tape in accordance with cable manufacturer recommendations for applications of dissimilar metals.
- .5 Make cable terminations by using factory-made kits. Obtain tools for cable terminals from cable manufacturer. Complete terminations immediately once started to avoid moisture ingress from surrounding air. Incorporate connections to ferrous cabinets for single conductor cables with brass plates sized accordingly. Install brass plates complete with required drilled and tapped holes. Provide cable lugs of temperature rating in accordance with manufacturer instructions.
- .6 Cable Terminations: Use thermoplastic sleeving over bare conductors.
- .7 Where cables are buried in cast concrete or masonry, provide sleeve for exit and entry of cables.
- .8 Do not splice cables.
- .9 Terminate cables to transformers, motors and other vibrating equipment, with means and measures isolating cables from and compensate for effects of vibration in accordance with cable manufacturer recommendations.
- .10 Ground cabling.
- .11 Arrange for cable manufacturer certified technician to perform following:
 - .1 Inspect installation and associated work.

- .2 Test installed cables. Unless otherwise recommended by cable manufacturer, megger terminations checking that insulation resistance is in accordance with cable manufacturer requirements. Prior to completing each termination, test insulation resistance and follow cable manufacturer procedures until resistance reaches cable manufacturer listed acceptable level.
- .3 Prepare report consisting of test sheets with results of cables tested and compliance certificate signed by testing technician validating test results and documenting that work was performed to satisfaction of manufacturer.

3.07 INSTALLATION OF FIRE-RATED TYPES RC90 AND FAS 105 CABLES

- .1 Obtain installation and testing training from cable manufacturer. Install cable and terminate.
- .2 Submit with shop drawings, copy of manufacturer detailed installation manual and testing procedures. Provide fire-rated type cables for applications as noted.
- .3 For type FAS 105 cables, run in EMT conduits as approved by cable manufacturer. Comply with conductor conduit fill requirements of cable manufacturer installation guides.
- .4 Support RA90 armour cabling horizontally or vertically, every 1200 mm unless otherwise noted and supported each side of bends. Refer to cable manufacturer guidelines.
- .5 Provide metal C-channels, clips, wall brackets, and ancillary devices as required and as recommended by cable manufacturer suiting on-site installation conditions. Provide system of metal type C-channel hangers and rods spaced at minimum 1200 mm but as confirmed with cable manufacturer, for running of cables. Where clips and other hardware are in contact with cables, insulate cables and hardware with suitable tape in accordance with cable manufacturer recommendations for applications of dissimilar metals.
- .6 Make terminations of conductors with manufacturer approved components and connectors in accordance with manufacturer recommendations. Obtain tools for cable terminals from cable manufacturer. Terminations must be completed immediately once started to avoid moisture ingress from the surrounding air.
- .7 Splicing of cables is not permitted, unless recommended for acceptance by Consultant and splicing method is approved by cable manufacturer.
- .8 Where electrical boxes are used in installation, comply with cable manufacturer guidelines.
- .9 Terminate cables to transformers, motors and other vibrating equipment, with means isolating vibration in accordance with cable manufacturer recommendations.
- .10 Arrange for cable manufacturer certified technician to perform field quality work, including inspection, testing and verification of cables, and preparation and signing of verification reports.

3.08 INSTALLATION OF RA90 CABLES

- .1 Provide type RA90 type cables for applications as noted. Handle, install, and terminate in accordance with manufacturer recommendations and instructions and as specified.
- .2 Provide system of cable tray and steel C-channel support system for overhead suspended cable. Provide support system consisting of non-ferrous cable trays supported by channels which are supported by threaded steel rods secured to structure with aluminum clips.

- .3 Tie wraps are not acceptable for securing cables. Utilize non-ferrous single screw cable clamps.
- .4 Ground and bond single conductor cables at both ends where sheath currents do not affect cable ampacity. For certain areas, where sheath currents reduce cable ampacity, ground and bond cable at supply end and isolate cable at load end, as recommended by cable manufacturer. Provide no smaller than No. 3/0 AWG green insulated copper ground conductor for each cable run.

3.09 FIELD QUALITY CONTROL

- .1 Inspection, Testing and Verification:
 - .1 Perform work in accordance with wire and cable manufacturer recommendations.
 - .2 Visually inspect wires and cables for damage or irregularities not consistent to new products.
 - .3 Perform installation insulation resistance tests on new wire and cable only.
 - .4 Perform installation tests directly after cable installation, and before termination to equipment or accessories.
 - .5 Perform test is "pass/fail" type of test, to determine if insulation has been damaged during installation.
 - .6 Verify that insulation resistance is in accordance with manufacturer acceptable limits.
 - .7 After terminations and connections are made, inspect terminations and connections.
- .2 Prepare testing and verification reports signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 41-[13(R2017)], Grounding and Bonding Equipment (Tri-National Standard, with NMX-J-590- ANCE and UL 467).
 - .2 CAN/CSA-C22.2 No. 65-[18], Wire Connectors (Tri-National Standard with NMX-J-543-ANCE and UL 486A-486B).
 - .3 CSA C22.2 No. 188-[18], Splicing Wire Connectors (Tri-National Standard, with UL 486C and NXM-J- 548-ANCE), Includes Update No. 1 (2019).
 - .4 C22.2 No. 1691-[21], Single Pole Locking-Type Separable Connectors (Bi-National Standard, with UL 1691).

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.

2. Products

2.01 ALUMINUM CONNECTORS

- .1 Where aluminum conductors are provided subject to Owner approval and recommendation for acceptance by Consultant, provide aluminum connectors CSA certified and marked for connection of aluminum conductors.

2.02 COMPRESSION TYPE CONNECTORS

- .1 In accordance with CAN/CSA-C22.2 No. 65 and CSA C22.2 No. 41.
- .2 CSA certified and marked.
- .3 With current carrying parts of copper sized fitting copper conductors.
- .4 Rated for copper solid, stranded and flexible conductors to 90°C.
- .5 Manufactured from high strength seamless copper tubing.
- .6 Electro-Tin plated.
- .7 Short and long barrel length, with chamfered entry.
- .8 Single hole and two holes.
- .9 Colour coded for die identification.
- .10 Capable of installation during types of weather events, humidity levels, and field conditions using standard industry tools.

2.03 FIXTURE TYPE SPLICING CONNECTORS

- .1 In accordance with CAN/CSA-C22.2 No. 65 and CSA C22.2 No. 188.
- .2 CSA certified.
- .3 600-Volt maximum voltage.
- .4 With current carrying parts of copper or copper alloy sized fitting copper conductors.
- .5 Set Screw Type:
 - .1 2 - piece wire connectors, with thermoplastic locking cap and brass insert with set screw.
- .6 Twist-On Type Connectors:
 - .1 Twist-on wire connector to join and insulate 2 or more wires.
 - .2 Flame-retardant shell rated at 105°C.
 - .3 Zinc plated steel insert.
 - .4 Springs expand accepting wire shape and size.

2.04 BUSHING STUD CONNECTORS

- .1 CSA certified.
- .2 Connector body and stud clamp fitting conductors.
- .3 Clamp for copper conductors.
- .4 Stud clamp bolts.
- .5 Bolts for copper conductors.
- .6 Sized fitting conductors.

2.05 CAM LOCK STYLE TYPE CONNECTORS

- .1 Single pole cam style connectors consisting of plugs and receptacles, generally as follows:
 - .1 In accordance with C22.2 No. 1691.
 - .2 CSA certified.
 - .3 Rated for up to 600 V AC/DC.
 - .4 Ratings and quantities: As noted or scheduled.
 - .5 Suitable for cable sizes and ampacity ratings.
 - .6 Mating male plugs and female receptacle colour-coded connectors.
 - .7 Double cam principle provides positive, vibration-proof connection.
 - .8 Locked contacts machined from high conductivity brass.
 - .9 Recessed contacts protected by insulating jacket.
 - .10 NEMA 3R rating.
- .2 Male plug and female receptacle connectors additional features:
 - .1 Watertight elastomeric rubber insulators/body moulded from colourfast material, colour-coded for easy phase identification.
 - .2 Non-vulcanized, single or double set screw connections.
 - .3 Vulcanized crimp connections.
 - .4 Locked brass contacts withstand pulling force of 4448 N.

- .5 1/3 turn provides high pressure contact approaching 0.42 kilograms-force per square millimeter.
- .6 Integrated strain relief system features retaining wire preventing cable jacket pull-away and bare conductor exposure.
- .7 Plugs typically for 250 MCM to 800 MCM: High strength, moulded-in-place locking ring to capture and secure insulator to contact.
- .3 Female receptacle stations additional features:
 - .1 Watertight elastomeric rubber body moulded from colourfast material, colour-coded for easy phase identification.
 - .2 Threaded stud or single/double hole bus bar type suiting intended application.
 - .3 Panel style mounting receptacles accommodate mounting onto surface mounting box.
 - .4 Enclosed box: CSA certified for intended application and sized accommodating receptacles and termination of wiring and conduit.
 - .5 NEMA 3R rating, high impact-resistant thermoplastic snapback covers with stainless steel hardware, and colour coded for easy phase identification.
 - .6 Engraved identification nameplate.

2.06 FLEXIBLE ARMoured CABLE FITTINGS

- .1 Saddle type, constructed of malleable iron/steel, electro-zinc plated inside and outside.
- .2 Equipped with nylon-insulated throat or anti-short bushing suiting specific applications.

2.07 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Cam Lock Style Connectors:
 - .1 Eaton (Crouse-Hinds).
 - .2 Hubbell.
 - .3 ABB (T&B).
 - .4 Leviton.

3. Execution

3.01 INSTALLATION - GENERAL

- .1 Remove insulation from ends of conductors and cables.
- .2 Clean conductor contact area.
- .3 General circuit conductors sized 3/0 AWG and greater: Provide long barrel double crimp, 2 hole compression type lug connectors.
- .4 Install compression pressure type connectors with compression tool and application die suiting intended applications.
- .5 Install fixture type connectors to conductors and tighten-on.
- .6 Install bushing stud connectors.
- .7 Install devices in accordance with manufacturer instructions.
- .8 Perform installations meeting secureness tests in accordance with CAN/CSA-C22.2 No. 65.

3.02 INSTALLATION OF CAM LOCK STYLE CONNECTORS

- .1 Provide cam lock style connectors. Install devices in accordance with manufacturer instructions.
- .2 Install female receptacle connector to cables. Provide male plugs of mating compatibility to female receptacle. Include for same quantify as receptacles. Turn over loose plugs to Owner, as reviewed with Consultant.
- .3 Install female receptacle stations in locations. Install in surface mounted wall boxes. Install cover onto stations.
- .4 Prior to roughing-in, review exact locations with Consultant.
- .5 Provide engraved lamacoid nameplates for devices and stations. Prior to ordering, review nomenclature of nameplate with Consultant.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Testing and Verification:
 - .1 Inspect, test and verify products.
 - .2 Check connections and operations.
 - .3 Perform secureness tests in accordance with CAN/CSA-C22.2 No. 65.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/Telecommunications Industries Association (ANSI/TIA):
 - .1 ANSI/TIA-607-D-[2019], Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- .2 CSA Group (CSA):
 - .1 CSA C22.1-[24], Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No. 41-[13(R2017)], Grounding and Bonding Equipment (Tri-national Standard, with NMJ-J-590- ANCE and UL 467).
- .3 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE 80-[2013], IEEE Guide for Safety in AC Substation Grounding (Incorporates IEEE Std P80-2013/Cor 1-2015).
 - .2 IEEE 837-[2014], IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports. Where requested in Specification, provide test reports, prepared and sealed by Professional Engineer.

2. Products

2.01 MATERIALS

- .1 Standards:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 In accordance with CSA C22.2 No. 41.
 - .3 For substations and vaults, and other locations as required by authorities having jurisdiction: IEEE 80 and IEEE 837.
- .2 Conductor Sizes:
 - .1 As specified or as indicated or scheduled.
 - .2 Where not indicated or scheduled, in accordance with CSA C22.1 and local governing electrical code.

2.02 GROUNDING AND BONDING CONDUCTORS

- .1 Bare:
 - .1 Stranded copper, soft annealed.
- .2 Insulated:
 - .1 Green polyvinylchloride jacketed.
 - .2 Compacted and stranded copper conductors.

2.03 GROUNDING SYSTEM COMPONENTS

- .1 Non-corroding, of compatible materials, including:
 - .1 Rod Electrodes: Copper clad steel, 19 mm diameter by not less than 3 m long, unless otherwise noted.
 - .2 Plate Electrodes: Copper, surface area not less than 0.2 m², not less than 1.6 mm thick, unless otherwise noted.
 - .3 Grounding Bar: Copper in accordance with details.
 - .4 Ground Bus: Copper, complete with insulated supports, fastenings, connectors and pre-drilled for two-hole lug connectors. Bus sized as noted, but not less than 50 mm x 9 mm x 900 mm. Provide continuous lengths where noted.
 - .5 Grounding and bonding bushings.
 - .6 Clamps for grounding of conductors.
 - .7 Bolted type conductor connectors.
 - .8 Bonding jumpers, straps.
 - .9 Pressure wire connectors.
 - .10 Bolted removable test links.
 - .11 Cable sheath isolating sleeves.
 - .12 Wire Connectors and Terminations: Suiting wiring types and specific applications.
- .2 Exothermic Welded Grounding:
 - .1 Process of welding conductor connectors.
 - .2 Consisting of manufacturer packaged materials providing welding connections made by exothermic welding process of joining similar metals using high temperature reaction of powdered copper oxide and aluminum.
- .3 Mechanical Grounding Connector:
 - .1 Type for above ground or within inspection pits.
 - .2 Connecting cable to rod or pipe, or other types suiting intended applications.
 - .3 High copper alloy.
 - .4 U-Bolts, nuts and lock-washers of bronze construction.
 - .5 Corrosion-resistant.
- .4 Miscellaneous Ancillary Components: Suiting requirements for completing grounding and bonding work.

2.04 GROUND PIT

- .1 Flush in grade grounding pits with following features:

- .1 Removable, cast concrete cover with securing hardware, recessed lifting handle and identification.
- .2 Cast iron or precast concrete pit, suiting intended applications.
- .3 Ground rod, ground clamps and grounding conductors.
- .4 Clay sewer tile for proper drainage.
- .5 Include following when detail is included on drawings.
- .6 Additional requirements in accordance with details.

2.05 TELECOMMUNICATIONS GROUNDING AND BONDING

- .1 Include requirements specified in this Section and additional requirements in Division 27.
- .2 Telecommunications Equipment Rack and Cabinet Ground Bars: Solid copper ground bars designed for mounting on framework of open or cabinet-enclosed equipment racks with dimensions not less than 6 mm thick by 20 mm wide.
- .3 At equipment mounting location (backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted: Screw lug-type terminal blocks. Where bolting to painted surfaces, use paint piercing type washers.
- .4 LAN Room Ground Bus: Not less than 50 mm x 9 mm x 300 mm unless otherwise noted, copper ground bus with eight drilled taped holes, mounted on walls with standoff insulators.
- .5 Ground Conductor for Grounding Grid and Associated Connections: Not less than No. 3/0 AWG unless otherwise noted, bare, seven-strand medium hard-drawn copper.
- .6 Ground Braid: Constructed from flat 98% conductivity tinned copper grounding braid.

2.06 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Compression Connectors, Ground Rods, Bus Bars, Fittings:
 - .1 nVent – Erico.
 - .2 ABB – T&B.
 - .3 ILSCO.
- .2 Exothermic Process:
 - .1 Cadweld (nVent - Erico).
 - .2 Hubbell – Burndy.

3. Execution

3.01 INSTALLATION – GENERAL

- .1 Provide bare grounding and bonding conductors for following applications, unless otherwise noted:
 - .1 Ground busses.
 - .2 Electrode interconnections.
 - .3 Metal structures.
 - .4 Gradient control mats.
 - .5 Transformers.
 - .6 Switchgear.

- .7 Motors.
- .8 Equipment grounding connections as noted.
- .9 Lightning protection ground grids.
- .2 Provide insulated grounding and bonding conductors for following applications unless otherwise noted:
 - .1 Grounding meters.
 - .2 Relay cases.
 - .3 Grounding cable sheaths.
 - .4 Raceways.
 - .5 Pipe work.
 - .6 Screen guards.
 - .7 Switchboards and panelboards.
 - .8 Potential transformers.
 - .9 Equipment grounding connections as noted.

3.02 HIGH VOLTAGE WORK GROUNDING AND BONDING

- .1 Provide grounding and bonding work in accordance with drawings and AHJ and referenced standards.
- .2 Install continuous grounding and bonding systems including, electrodes, conductors, connectors and accessories.
- .3 Provide applicable grounding requirements for electrical utility pad mounted transformer in accordance with utility requirements. Provide ground electrode consisting of minimum four ground rods (unless otherwise detailed or otherwise required by electrical utility or electrical code) driven into grade in arrangement as required and interconnected with minimum No. 4/0 bare copper conductor. Drive and bury ground rods at depth in accordance with electrical code. Connect transformer to ground electrode with 2 runs of minimum No. 4/0 bare copper conductor.
- .4 Ground fences to grounding system independent of station ground.
- .5 Protect exposed grounding conductors during and after construction.
- .6 Install connectors and exothermic weld in accordance with manufacturer instructions.
- .7 Make buried connections, and connections to electrodes, and structural steel work, using copper welding by thermite process and manufacturer packaged materials in accordance with manufacturer instructions.
- .8 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .9 Use minimum No. 4/0 AWG bare copper cable for main ground bus of substation and minimum No. 2/0 AWG bare copper cable for taps on risers from main ground bus to equipment. Increase cable sizes to requirements where noted on drawings.
- .10 Install No. 3/0 AWG extra flexible (425 strands) copper conductor for connection of switch mechanism operating rod to gradient control mat, fence gates and vault doors.
- .11 Install tinned copper conductors for aluminum structures.
- .12 Do not use bare copper conductors near un-jacketed lead sheath cables.

- .13 Size ground conductors that are not sized on drawings, in accordance with governing electrical code. Do not size ground conductors smaller than requirements specified or indicated on drawings.
- .14 Electrodes:
 - .1 Install ground rod electrodes. Drive and bury ground rods at depth in accordance with AHJ requirements.
 - .2 Make grounding connections to station equipment.
 - .3 Install ground rod electrodes at transformer and switchgear locations.
 - .4 Install gradient control mats. Connect mats to station ground electrode and switch mechanism operating rods.
 - .5 Make special provision for installing electrodes that give acceptable resistance to ground value where rock or sand terrain prevails. Ground as noted.
- .15 Equipment Bonding:
 - .1 Install bonding connections to station equipment, including:
 - .1 Metallic water main, line sky wire, neutral, gradient control mats.
 - .2 Non-current carrying parts of transformers, generators, motors, circuit breakers, reclosers, current transformers, frames of gang-operated switches and fuse cutout bases.
 - .3 Cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers.
 - .4 Meter and relay cases.
 - .5 Exposed building metal, within or forming part of station enclosure.
 - .6 Sub-station fences, pothead bodies.
 - .7 Outdoor lighting.
 - .2 Bond hinged doors to main frame of electrical equipment enclosure with flexible jumper.
 - .3 Connect metallic piping (water, oil, air) inside station to main ground bus at several locations, including each service location within station.
 - .4 Make connections to metallic water pipes outside station to assist in reduction of station ground resistance value.
- .16 Neutral Grounding:
 - .1 Connect transformer neutral and distribution neutral together using 1000 V insulated conductor to one side of ground test link, other side of test link being connected directly to main station ground. Bond distribution neutral and neutrals of potential transformers and service banks directly to transformer neutral and not to main station ground.
 - .2 Interconnect electrodes and neutrals at each grounding installation.
 - .3 Connect neutral of station service transformer to main neutral bus with tap of same size as secondary neutral.
 - .4 Ground transformer tank with continuous conductor from tank ground lug through connector on ground bus to primary neutral. Connect neutral bushing at transformer to primary neutral in same manner.
- .17 Pole Mounted Switching Device Grounding:
 - .1 Drive four ground rods 3 m long at base of each pole on which group-operated line switching devices are mounted.

- .2 Arrange rods in square formation with 3 m sides, located for operator standing within square to operate switch.
- .3 Interconnect ground rods with minimum No. 2/0 AWG stranded annealed copper conductor and join to switch operating handle ground wires.
- .4 Connect operating handle of switch to handle base with minimum No. 3/0 AWG extra flexible copper conductor.
- .18 Pole Mounted Transformer Grounding:
 - .1 Drive ground rods at base of each pole on which transformers are mounted and interconnect transformer, system neutral, lightning arresters and ground rods.
- .19 Grounding in Manholes:
 - .1 Install grounding stud and electrodes.
 - .2 Install ground rod with lug for grounding connection in each manhole so that top projects through bottom of manhole. Provide with lug for grounding connection. Test that ground resistance is in accordance with CSA C22.1 and provincial electrical code requirements.
- .20 Cable Sheath Grounding:
 - .1 Bond single conductor, metallic sheathed cables together at one end only. Break sheath continuity by inserting insulating sleeves in cables or using special isolating transformer.
 - .2 Use minimum No. 6 AWG flexible copper wire soldered, not clamped, to cable sheath.
 - .3 Connect bonded cables to ground with minimum No. 2/0 AWG copper conductor.

3.03 LOW VOLTAGE WORK GROUNDING AND BONDING

- .1 Provide grounding and bonding work in accordance with drawings and authorities having jurisdiction and referenced standards.
- .2 Provide electrical utility grounding requirements for stations, vaults and electrical rooms. Review requirements with electrical utility. Comply with requirements of IEEE 837.
- .3 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run separate ground wire in conduit.
- .4 Install bonding conductors and connect.
- .5 Install connectors in accordance with manufacturer instructions.
- .6 Protect exposed grounding conductors from mechanical injury.
- .7 Make exposed ground connections using compression connectors and other grounding fittings suitable for applications.
- .8 Make buried connections, and connections to electrodes, and structural steel work, using copper welding by thermite process and manufacturer packaged materials in accordance with manufacturer instructions.
- .9 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .10 Soldered joints not permitted.
- .11 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Cleat bonding wire to exterior of flexible conduit.

- .12 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .13 Install separate ground conductor to outdoor lighting standards.
- .14 Connect building structural steel and metal siding to ground.
- .15 Make grounding connections in radial configuration only, with connections terminating at single grounding point typically at street side of metallic water pipe. Avoid loop connections.
- .16 Bond single conductor, metallic armoured cables to cabinet at supply end and load end.
- .17 Ground secondary service pedestals.
- .18 Install grounding connections to equipment including following:
 - .1 Service equipment, transformers, switchgear, motor control centres, starters, control panels, generators, panel boards.
 - .2 Elevators and escalators.
 - .3 Cable trays, duct systems, frames of motors.
 - .4 Outdoor lighting.
 - .5 Building steel work.
- .19 Connect grounding conductors to motors 1 HP and above or circuits 20 A and above, with solderless terminal and bolt tapped to motor frame or equipment housing. Connect to smaller motors or equipment by fastening terminal to connection box. Connect junction boxes to equipment grounding system with grounding clips mounted directly on box or with machine screws. Remove paint, dirt, or other surface coverings at grounding conductor connection points to provide good metal-to-metal contact.
- .20 Ground metal sheathing and exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Bond metal equipment platforms which support electrical equipment to equipment ground. Bond rooftop equipment.
- .21 Bond metal work associated with pools such as reinforcing steel, piping, ladders and ancillary devices, above ground loops by copper conductors in accordance with local governing electrical code. Clean water pump prior to bond being using approved clamps. As required, make several bonds at various locations or collect wires and make one bond. Ground electrical equipment associated with these piping systems, adequately by installing flexible conduit and ground jumper wire to motors. Ground telephone boxes, speakers, pull stations and other such equipment within pool area with jumper wires within connecting conduit to ensure proper grounding. Include for ground connections to pool reinforcing steel.
- .22 Provide separate ground connection for bathtubs.
- .23 Ground and bond various telecommunications, audio visual systems, security, life safety and control systems in accordance with respective system manufacturer recommendations.
- .24 Install system and circuit grounding connections to systems.
- .25 Provide separate insulated ground wire for each isolated ground receptacle.
- .26 Extend isolated grounding conductors of computer receptacles to isolated ground bus of computer panel board serving area. From ground bus, extend ground conductors to building grounding station.

- .27 In areas of raised floor systems, provide copper ground system. Bond ground system to raised floor supports and floor structure using ground clamps suitable for application, and connect system to building ground system with grounding conductors run in conduit. Bond metallic conduit which penetrates raised floor, to raised floor stringer system. Install clamps and other accessories in accordance with manufacturer recommendations and instructions.
- .28 Size ground conductors that are not sized on drawings in accordance with authorities having jurisdiction requirements. Size ground conductor no smaller than requirements specified or indicated on drawings..
- .29 Electrodes:
 - .1 Within designated electrical rooms, provide ground electrodes consisting of ground rods as required by governing electrical code, driven into grade and interconnected with copper ground conductors. Provide, drive and bury ground rods at depth, in accordance with electrical code. Refer to details on drawings.
 - .2 Make ground connections to continuously conductive underground water pipe on street side of water meter.
 - .3 Install water meter shunt, as applicable.
 - .4 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
 - .5 Install rod and plate electrodes and make grounding connections to suit intended applications.
 - .6 Bond multiple electrodes together and bond locations of groups of electrodes together.
 - .7 Provide size No. 4/0 AWG copper conductors or greater, for connections to electrodes.
 - .8 Make grounding provision for installing electrodes with acceptable resistance to ground value, where rock or sand terrain prevails.
- .30 Grounding Bus:
 - .1 Install copper grounding bus mounted on insulated supports on wall of electrical rooms and communication equipment rooms.
 - .2 For electrical rooms provide no smaller than 50 mm x 9 mm x 900 mm electrical grade copper ground bus on perimeter wall of electrical rooms, 300 mm above finished floor level. Secure ground bus on 20 mm standoff insulators. Connect electrical rooms ground grid with ground bus with no smaller than 3/0 copper ground conductor in conduit. Connect each electrical room perimeter ground electrode system back to main electrical room ground electrode with no smaller than No. 4/0 copper conductors. Refer to drawings and increase dimensions of ground bus and conductors to drawing indicated sizes.
 - .3 Ground items of electrical equipment in electrical room and IT equipment in communication equipment room to ground bus with individual bare stranded copper connections no smaller than No. 2/0 AWG. Increase size to suit intended applications and local electrical code requirements.

3.04 CABLE SHEATH GROUNDING

- .1 Bond single conductor, metallic sheathed cables together at one end only. Break sheath continuity by inserting insulating sleeves in cables or using special isolating transformer.
- .2 Provide minimum No. 6 AWG flexible copper wire soldered, not clamped, to cable sheath.

- .3 Connect bonded cables to ground with minimum No. 2/0 AWG copper conductor.

3.05 GROUNDING IN MAINTENANCE HOLES

- .1 Install grounding stud, electrode, and stranded copper conductor sized in accordance with local governing electrical code, in each maintenance hole.
- .2 Install ground rod in each maintenance hole so that top projects through bottom of maintenance hole. Provide with lug for grounding connection. Test that ground resistance is in accordance with CSA C22.1 and provincial electrical code requirements.

3.06 TELECOMMUNICATIONS GROUNDING

- .1 Provide grounding and bonding in accordance with ANSI/TIA-607-D requirements.
- .2 Provide wire and hardware required to properly ground, bond, and connect communications raceway, cable tray, metallic cable shields, and equipment to ground source.
- .3 Provide continuous ground bonding jumpers with no splices. Use shortest length of bonding jumper possible.
- .4 Provide ground paths which are permanent and continuous with resistance of 5 ohms or less from raceway, cable tray, and equipment connections to building grounding electrode. Test that measured resistance across individual bonding connections is of value 10 milliohms or less.
- .5 Provide communications room telecommunications ground busbar hardware at cable tray height.
- .6 Connect busbar to building ground busbar located in same room using two-hole compression lugs and grounding jumper of same size as pigtail extension of main building grounding ring (minimum 3/0 AWG).
- .7 Ground metallic conduits, wireways, and other metallic equipment located away from equipment racks or cabinets to cable tray pan or telecommunications ground busbar, whichever is closer, using insulated minimum No. 6-AWG ground wire bonding jumpers.
- .8 Ground metallic conduit at each end using minimum No. 6-AWG bonding jumpers.
- .9 Perform cable tray grounding and bonding in accordance with manufacturer recommendations. Bond metallic structures of wireway to provide 100% electrical continuity throughout wireway system.
- .10 Refer to additional grounding and bonding requirements specified in Division 27.

3.07 FIELD QUALITY CONTROL

- .1 After installation work is complete, inspect work and check connections.
- .2 Before backfilling, engage independent testing agent to inspect grounding and perform ground resistance test. Before energizing electrical system, perform tests.
- .3 Perform ground continuity and ground resistivity tests using method appropriate to site conditions, approved by AHJ and reviewed with Consultant.
- .4 Provide step-and-touch potential calculations using measured station ground resistance measurements. Document results in report.
- .5 Test grounding and bonding systems, verifying 100% electrical continuity throughout.

- .6 Telecommunications Systems: Test that measured resistance across individual bonding connections is 10 milliohms or less.
- .7 Disconnect ground fault indicators during tests.
- .8 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

3.08 FIELD QUALITY CONTROL

- .1 After installation work is complete, inspect work and check connections.
- .2 Before backfilling, engage independent testing agent to inspect grounding and perform ground resistance test. Before energizing electrical system, perform tests.
- .3 Perform ground continuity and ground resistivity tests using method appropriate to site conditions, approved by AHJ and reviewed with Consultant.
- .4 Provide step-and-touch potential calculations using measured station ground resistance measurements. Document results in report.
- .5 Test grounding and bonding systems, verifying 100% electrical continuity throughout.
- .6 Telecommunications Systems: Test that measured resistance across individual bonding connections is 10 milliohms or less.
- .7 Disconnect ground fault indicators during tests.
- .8 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American Society for Testing and Materials (ASTM):
 - .1 ASTM A123/A123M-[17], Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A653/A653M-[20], Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .3 ASTM A1011/A1011M-[18a], Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - .4 ASTM B633-[19], Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, load ratings, installation spacing, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include with shop drawings for equipment supports designed by manufacturer specifically for project equipment:
 - .1 Full details of design criteria.
 - .2 Design calculations.
 - .3 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.
 - .4 Installation procedures and instructions.
 - .5 Testing and verification procedures.
 - .6 Stamp and seal of design Professional Engineer licensed in Place of Work.
- .3 Submit testing and verification reports.

2. Products

2.01 EQUIPMENT SUPPORTS

- .1 Design, construct and install metal supports, stands, platforms and other metal structures required for and associated with equipment. Design equipment supports to properly distribute loads and impact loads onto building structure.
- .2 Where equipment is indicated or specified to be floor mounted on stands or legs, fabricate these from structural steel section or steel pipe with adequate bracing and steel plate flanges for bolting to concrete housekeeping pad.

- .3 Where ceiling or wall mounting is indicated on drawings or specified, provide suspended platform, bracket or shelf, whichever is most suitable for equipment and its location. Fabricate from standard structural steel sections and plate or steel pipe. Securely fasten structures to building structure.
- .4 Support equipment suspended above floor level with suitable welded or bolted prime coat painted structural steel angles or channels bracketed to wall or secured by hanger rods.
- .5 Provide supports large enough to support equipment along entire length and width. Install isolators when necessary, either below support or between support and equipment.

2.02 ANCHOR BOLTS, ANCHOR RODS, LIFTING EYES AND HOOKS

- .1 Anchor Bolts, Anchor Rods and Anchors:
 - .1 Engage delegated design Professional Engineer to design and certify required anchors for applications.
 - .2 Corrosion-resistant.
 - .3 Suiting applicable requirements for seismic and vibration isolation.
 - .4 Suiting materials of construction on which embedded.
- .2 Lifting Eyes and Hooks:
 - .1 Where lifting eyes, hooks or similar means are not included with equipment from manufacturers, provide steel lifting eyes and hooks of type and lifting capacity to accommodate weight of equipment.
 - .2 Provide galvanized steel types or other corrosion-resistant finish for products located in non-climate-controlled areas.
- .3 Anchor Bolt Templates:
 - .1 Templates accurately locate anchor bolts suiting equipment requirements.
- .4 Provide anchors, fasteners and other securing hardware of capacity and type suiting application and for which materials to which hardware are being installed. Include manufacturer product literature with shop drawing submissions detailing that supplied hardware is suitable for respective applications.

2.03 SUPPORT CHANNELS

- .1 Climate-controlled Areas:
 - .1 In accordance with ASTM A653/A653M SS GR 33.
 - .2 Pre-galvanized steel, 0.75 mil zinc-coated by hot-dip process, U-shape, sized suiting application but no smaller than 41 x 41 mm and greater where noted, and not less than 2.5 mm thick.
 - .3 Type used in poured concrete walls and ceilings or suspended or surface-mounted, suiting intended applications.
- .2 Non-climate-controlled Areas:
 - .1 In accordance with ASTM A1011/A1011M.
 - .2 Finishes: In accordance with ASTM A123/A123M.
 - .3 Hot dipped galvanized steel, 2.6 mil zinc-coated, U shape, sized suiting application but no smaller than 41 x 41 mm, and greater where noted, and not less than 2.5 mm thick.
 - .4 Type set in poured concrete walls and ceilings or suspended or surface-mounted, suiting specific applications.

- .3 Selected channel type to support loading for specific applications in accordance with manufacturer limitations.
- .4 Include anchorage, suspended supports flanges, brackets, rods, pedestals and clamps, suiting intended applications.

2.04 ROOFTOP CONDUIT SUPPORT SYSTEM

- .1 Rooftop support systems with features as follows:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 Non-penetrating of roof.
 - .3 Vibration dampening.
 - .4 Does not float.
 - .5 Suitable for outdoor wet and freezing environments without damage caused by weather or freeze and thawing when exposed to de-icing chemicals.
 - .6 Environmentally friendly.
 - .7 Constructed of recycled rubber.
- .2 Materials:
 - .1 Constructed of 100% recycled rubber and polyurethane pre-polymer with a uniform load capacity suiting intended load application of support (minimum rating 744 kg/m). Each base with reflective red stripe.
- .3 Low Lying Base:
 - .1 Dimensions: 150 mm wide by 125 mm tall by required overall length (minimum 225 mm). This is minimum dimensions, but increase base requirements, suiting intended applications as recommended by system manufacturer.
 - .2 Low base galvanized steel frame C channel 14 gauge - 25 mm high strut galvanized in accordance with ASTM A653/A653M.
 - .3 Pipe roller assembly.
- .4 Elevated Base:
 - .1 Two 13 mm diameter electro zinc threaded rod risers and 14 gauge - 25 mm high galvanized steel slotted channel.
 - .2 Adjustable height up to 400 mm, and as indicated.
 - .3 Pipe roller assembly.
- .5 Attaching Hardware: Zinc-plated threaded rod, nuts and attaching hardware in accordance with ASTM B633.
- .6 Pipe Clamps: Single pipe supports constructed of galvanized steel and sized accommodating sizing of installed conduits.
- .7 Review with system manufacturer that selected products provide proper support for intended application.

2.05 SEISMIC RESTRAINTS

- .1 Refer to Section 26 05 48 - Vibration and Seismic Controls.

2.06 OTHER EQUIPMENT SUPPORTS

- .1 Submit structural calculations with shop drawings.

- .2 Concrete Pads: Refer to Section 26 05 00 – Common Work Results for Electrical.

2.07 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Support Channels:
 - .1 Unistrut.
 - .2 ABB (T&B).
 - .3 Hilti.
 - .4 Eaton B-Line.
- .2 J-Hooks:
 - .1 Pentair – Erico.
 - .2 Panduit.
- .3 Roof Top Conduit Support Systems:
 - .1 Eaton – Cooper.
 - .2 Clearline Technologies.
 - .3 Erico.

3. Execution

3.01 INSTALLATION - GENERAL

- .1 Fastenings:
 - .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials.
 - .2 Prevent electrolytic action and corrosion between dissimilar metals and materials by using suitable non-metallic strips, washers, sleeves, or other permanent separators to avoid direct contact.
 - .3 Use non-corrosive fasteners and anchors for securing exterior work and in spaces where high humidity levels are anticipated.
 - .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage.
 - .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
 - .6 Do not use fastenings or fastening methods that may cause spalling or cracking of material to which anchorage is made.
 - .7 For equipment, use fastenings of standard commercial sizes and patterns with material and finish suitable for service. Install bolts not projecting more than one diameter beyond nuts.
- .2 Secure equipment to surfaces with nylon shields or lead anchors, suiting types of surfaces and applications.
- .3 Secure equipment to poured concrete with expandable inserts.
- .4 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .5 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Support T bars to carry weight of equipment specified.
- .6 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories, to basic channel members.

- .7 Fasten exposed conduit or cables to building construction or support system using straps, by means as follows:
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .8 Suspended Support Systems:
 - .1 Support individual cable or conduit runs with not smaller than 6 mm diameter threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by not smaller than 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .9 For surface mounting of two or more conduits, provide steel C- channels secured to surfaces with manufacturer recommended hardware, suiting intended application.
- .10 Install C-channel supports in accordance with manufacturer instructions and recommendations, maintaining span and loading limits.
- .11 Provide metal brackets, frames, hangers, clamps and related types of support structures, to support conduit and cable runs.
- .12 Provide support for raceways and cables dropped vertically to equipment where there is no wall support.
- .13 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .14 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade, review with Consultant and obtaining recommendation from Consultant.
- .15 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer installation recommendations.
- .16 Review with and obtain recommendation for acceptance from Consultant if wood shims are proposed to be used with hangers.
- .17 Coordinate provision of concrete for concrete pads in accordance with 26 05 00 – Common Work Results for Electrical.
- .18 Coordinate work with applicable requirements of Division 13 and Structural Consultant.
- .19 Vibration Control Devices: Install on piping systems at pumps, chillers, cooling towers, and other equipment as noted. Refer to Section 26 05 48 - Vibration and Seismic Controls.

3.02 INSTALLATION OF ANCHOR BOLTS, ANCHOR RODS, LIFTING EYES AND HOOKS

- .1 Install anchors, alignment guides and lifting components in accordance with equipment manufacturer recommendations suiting equipment and anchoring requirements.
- .2 Set anchor bolts, anchor rods, sleeves, washers, nuts and provide templates to locate positions of bolts.
- .3 Set sleeves flush with or slightly above top surface or rough concrete.
- .4 Provide anchor bolts with right-angles bends or hooks, or with square plate washers, threads and nuts for anchoring. Do not use expansion shields or similar devices for anchoring equipment to concrete bases.

- .5 Locate anchors suiting equipment as installed and requirements of reviewed anchor shop drawings.
- .6 Where equipment is not in banks, provide two-eye hooks above each piece of equipment.

3.03 INSTALLATION OF ROOFTOP CONDUIT SUPPORT SYSTEMS

- .1 Select and install rooftop support system for conduits/raceways in accordance with manufacturer instructions and recommendations, suiting type and size of raceway, and roofing materials. Verify load ratings with manufacturer and provide support system to accommodate required loads.
- .2 Install system at height as indicated and as reviewed with Consultant.
- .3 For gravel top roofs, remove gravel from around and under pipe support. Coordinate work with building roofing vendor confirmed with Owner and reviewed with Consultant.
- .4 Consult vendor of installed roofing for roof membrane compression capacities and roof loading limitations. Comply with restrictions.
- .5 Use clamps sized suiting conduit sizes. Verify that installation and use of system does not invalidate installed roof warranties.
- .6 Engage vendor of installed roofing to inspect installation and verify that installation has not damaged roof.

3.04 FIELD QUALITY CONTROL

- .1 Inspection, Testing and Verification:
 - .1 Inspect, test and verify products.
 - .2 Check connections and operations.
- .2 Where delegated design, include for delegated design Professional Engineer to witness testing and also sign reports.
- .3 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.1-[24], Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No. 40-[17], Junction and Pull Boxes.
 - .3 CSA C22.2 No. 76-[14(R2019)], Splitters.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, load ratings, installation spacing, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports.

2. Products

2.01 SPLITTERS

- .1 Standards: In accordance with CSA C22.2 No. 76.
- .2 Construction: CSA certified, factory primed and painted sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position. Complete with suitable mounting provisions.
- .3 Terminations: Connection blocks, or main and branch lugs, matching size, type and number of incoming and outgoing conductors.
- .4 Spare Terminals: No less than three spare terminals or lugs, suiting intended applications, on each connection or lug block sized less than 400 A.

2.02 STANDARD JUNCTION BOXES AND PULL BOXES

- .1 Standards: In accordance with CSA C22.2 No. 40.
- .2 Galvanized or prime coat plated steel construction, with screw-on or hinged covers suiting intended applications, and connectors suiting connected conduit.
- .3 CSA certified, "FS" or "FD" Series cast ferroalloy and aluminium boxes.
- .4 CSA certified rigid plastic (PVC) boxes.
- .5 Covers Flush Mounted: 25 mm minimum extension beyond box sides.
- .6 Covers Surface Mounted: Screw-on flat or turned edge covers, suiting intended applications.

- .7 Corrosion-resistant, flame-resistant, salt spray resistant, boxes and covers, uniformly coated inside and outside with epoxy acrylic of nominal thickness 0.05 mm. Covers secured with stainless steel screws.
- .8 Provide boxes suiting intended applications, with securing lugs, connectors suiting connected conduit, knockouts, plaster rings, concrete rings, covers, carpet flanges and other accessories suiting surface constructions.
- .9 Boxes exposed exterior of building or in non-climate-controlled locations: Weatherproof boxes with gasketed covers or faceplates.
- .10 Physical Size of Boxes: Unless otherwise noted, in accordance with electrical code, suiting number and size of conduits and conductors, and conductor bending radii.

2.03 SPLICE BOXES

- .1 Features:
 - .1 Cast iron enclosures no less than 6 mm thick painted with chromate primer and grey enamel, providing mechanical protection and moisture seal for direct buried cable splices rated for various voltage levels.
 - .2 Consisting of two halves, split along cable axis, finely ground matching surfaces, fastened with silicon bronze or galvanized steel bolts; top half with large filling holes with gasketed plugs for medium hard asphalt base compound.
 - .3 Bottom half with screws on inside for bonding, and box end openings sealed by:
 - .1 Wrapping cables with anhydrous tape and clamping making snug fit, for splices.
 - .2 Fitting boxes with cable entrance fittings suiting types of cable sheaths, and splices.

2.04 ENCLOSURE RATINGS

- .1 Provide enclosures for products rated in areas as follows:
 - .1 Enclosures mounted in climate-controlled areas: NEMA 1, unless otherwise noted.
 - .2 Enclosures mounted in non-climate-controlled applications: NEMA 3R, unless otherwise noted.
 - .3 Enclosures mounted in corrosive environment applications: NEMA 4X, unless otherwise noted.
- .2 Equivalent IP rating is acceptable.

2.05 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Splitters:
 - .1 Bel Inc.
 - .2 Hydrel.
 - .3 Hammond.
- .2 Electrical Boxes:
 - .1 ABB (T&B).
 - .2 Eaton (Crouse-Hinds).
 - .3 Appleton.
 - .4 Iberville.

3. Execution

3.01 INSTALLATION OF SPLITTERS

- .1 Mount plumb, true and square to building lines.
- .2 Install with clearance for access for operation and maintenance.
- .3 Extend splitters full length of equipment arrangement, unless otherwise noted.
- .4 Secure splitter trough in place independent of connecting conduit, secure into position and connect complete.
- .5 Provide grounding and bonding.

3.02 INSTALLATION OF JUNCTION AND PULL BOXES

- .1 Provide pull boxes in conduit systems wherever:
 - .1 Indicated.
 - .2 Necessary facilitating conductor installations.
 - .3 Conduit runs exceed 30 m in length, or with more than two, 90° bends, and installed at convenient and suitable inconspicuous but accessible location.
- .2 Size boxes accommodating requirements of supplied system and for bending radii of installed cables. Review requirements with respective system vendors.
- .3 Provide sealing around boxes in walls where insulation and vapour barrier is present or for walls of rooms that are sealed. Maintain sealing system of wall.
- .4 Boxes in rigid conduit and EMT inside building: Stamped galvanized or prime coated steel.
- .5 Boxes in exterior rigid conduit and boxes in perimeter wall where insulation and vapour barrier is present: Cast gasketed boxes.
- .6 Boxes in Plastic Conduit: Rigid PVC plastic boxes complete with PVC couplings.
- .7 Provide epoxy coated boxes for epoxy coated conduit. Handle and install epoxy coated boxes in accordance with manufacturer instructions as not to damage epoxy coating. Seal joints with manufacturer sealing compound.
- .8 Accurately locate and identify concealed pull boxes and junction boxes on "As-built" record drawings.
- .9 Identify system of main pull or junction boxes by painting outside of covers. Review paint colour scheme with Consultant.
- .10 Cover boxes in fire walls with aluminium tape and seal with caulking. Provide specified firestopping and smoke seal materials.
- .11 Identify on drawings, main junction and main pull boxes. Install additional pull boxes as required by CSA C22.1 and local governing electrical code.
- .12 Provide grounding and bonding.
- .13 Provide blank coverplates on existing obsolete boxes that remain in position.

3.03 INSTALLATION OF SPLICE BOXES

- .1 Install splice boxes at cable joints, in accordance with manufacturer instructions.
- .2 Tighten armour clamps and fill with compound.

- .3 Provide grounding and bonding.

3.04 IDENTIFICATION

- .1 Equipment Identification: In accordance with Section 26 05 53 - Signage and Identification.
- .2 Identification Labels: Size 2 indicating voltage and phase and system name, unless otherwise noted.
- .3 Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting outside of covers. Spray painting is not permitted unless approved by Owner and reviewed with Consultant. Provide paint colours in accordance with following schedule, as reviewed with Consultant:
 - .1 Lighting: Yellow.
 - .2 Normal Power: Blue.
 - .3 Essential Power: Orange.
 - .4 Fire Alarm: Red.
 - .5 Telephone: Green.
 - .6 Miscellaneous Signals: Brown.
- .4 In addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed.
- .5 Identify on as-built drawings, main junction and main pull boxes.

3.05 FIELD QUALITY CONTROL

- .1 Inspection, Testing and Verification:
 - .1 Inspect, test and verify products.
 - .2 Check connections and operations.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.1-[24], Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No. 18.1-[13(R2022)], Metallic Outlet Boxes (Tri-national Standard, with UL 514A and ANCE NMX- J-023/1).
 - .3 CSA C22.2 No. 18.2-[06(R2021)], Nonmetallic Outlet Boxes.
 - .4 CSA C22.2 No. 30-[20], Explosion-Proof Equipment.
 - .5 CSA C22.2 No. 85-[14(R2023)], Rigid PVC Boxes and Fittings.
- .2 Ontario Electrical Safety Code (OESC), 28th Edition, 2021.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.

2. Products

2.01 OUTLET AND CONDUIT BOXES - GENERAL

- .1 General Requirements:
 - .1 In accordance with CSA C22.1 and provincial electrical code.
 - .2 CSA certified.
 - .3 With Internal green ground screws.
 - .4 Metallic Outlet Boxes: In accordance with CSA C22.2 No. 18.1.
 - .5 Non-Metallic Boxes: In accordance with CSA C22.2 No. 18.2.
 - .6 PVC Boxes: In accordance with CSA C22.2 No. 85.
 - .7 Faceplates: Refer to Section 26 27 26 - Wiring Devices.
- .2 Provide 102 mm square or larger outlet boxes.
- .3 Gang boxes where wiring devices are grouped.
- .4 Provide blank cover plates for boxes without wiring devices.
- .5 Provide 347 V outlet boxes for 347 V switching devices.
- .6 Provide combination boxes with barriers, where outlets for more than one system are grouped.

2.02 GALVANIZED STEEL OUTLET BOXES

- .1 Construction:
 - .1 One-piece electro-galvanized.
 - .2 Single and multi-gang as required.
 - .3 Flush device boxes for flush installation.
- .2 Types and Sizing:
 - .1 Minimum size 76 x 50 x 38 mm, or as noted.
 - .2 When more than one conduit enters one side with extension and plaster rings: 102 mm square outlet boxes.
 - .3 Utility boxes for outlets connected to surface mounted EMT conduit: Minimum 102 x 54 x 48 mm.
 - .4 Luminaire outlets: 102 mm square or octagonal outlet boxes.
- .3 Provide extension and plaster rings for flush mounting devices in finished tile or plaster walls.

2.03 CONCRETE BOXES

- .1 Concrete type boxes for flush mounting in concrete: Electro-galvanized sheet steel, with matching extension and plaster rings.

2.04 MASONRY BOXES

- .1 Masonry type boxes for devices flush mounted in exposed block walls: Electro-galvanized steel, single and multi-gang as required.

2.05 PVC BOXES

- .1 Standards: CSA certified rigid plastic (PVC) outlet boxes.

2.06 CAST BOXES

- .1 Cast FS/FD boxes:
 - .1 Ferroalloy iron construction.
 - .2 Gasketed covers, factory-threaded hubs and mounting feet for surface wiring of devices.
 - .3 Finish of electrogalvanized and aluminum acrylic paint.

2.07 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

2.08 EPOXY COATED OUTLET BOXES

- .1 Features:
 - .1 Corrosion resistant, flame-resistant and salt spray-resistant boxes and covers.
 - .2 Uniformly coated inside and outside with epoxy acrylic of nominal thickness 0.05 mm.
 - .3 Covers secured with stainless steel screws.

2.09 FITTINGS - GENERAL

- .1 Bushing and connectors: Include nylon insulated throats.
- .2 Device Plates: Of type and configurations suiting type of devices.
- .3 Knock-out fillers prevent entry of debris.
- .4 Conduit outlet bodies provided for conduit up to 35 mm and pull boxes provided for larger conduits.
- .5 Conduit outlet bodies NEMA 3R provided with raintight gasketed cover suitable for wet locations.
- .6 Double locknuts and insulated bushings provided on sheet metal boxes.
- .7 Weather-resistant and corrosion resistant for non-climate-controlled environments.

2.10 EXPLOSION-PROOF PRODUCTS

- .1 Products to be suitable for explosion-proof and dust ignition-proof hazardous location areas as defined in CSA C22.1 and OESC, including:
 - .1 Class I Division 1 and 2, Groups A, B, C, D.
 - .2 Class II, Division 1, Groups E, F, G.
 - .3 Class III, Division 1 and 2.
- .2 Standards:
 - .1 In accordance with CSA C22.2 No. 30.
 - .2 ULC listed and CSA certified.
- .3 Explosion-Proof Outlet Boxes and Junction Boxes:
 - .1 Installed in conduit systems within hazardous areas to:
 - .1 Provide protection against exterior explosion where acetylene, hydrogen and other hazardous gases are present.
 - .2 Protect conductors in threaded rigid conduit.
 - .3 Act as pull and splice boxes.
 - .4 Interconnect lengths of conduit.
 - .5 Change conduit direction.
 - .6 Provide access to conductors for maintenance and future system changes.
 - .2 Features:
 - .1 Various hub configurations suiting intended applications.
 - .2 Taper threaded hubs providing ground continuity.
 - .3 Smooth integral hub bushing protecting conductor insulation when pulling.
 - .4 Threaded cover openings.
 - .5 Surface covers.
 - .6 Neoprene O-ring gaskets and green ground screws.
 - .7 Mounting pads.
 - .8 Terminals blocks suiting intended applications.
 - .9 Bodies: Feraloy iron alloy construction with electrogalvanized and aluminum acrylic paint finishes.
 - .10 Covers: Copper-free aluminum construction with natural finishes.

.11 Suitable for raintight and wet location areas.

.4 Explosion-Proof Fittings: Refer to Section 26 05 34 Conduits, Conduit Fastenings and Fittings.

2.11 ACCEPTABLE PRODUCT MANUFACTURERS

.1 Outlet Boxes, Conduit Boxes and Fittings:

- .1 ABB (T&B).
- .2 Eaton (Crouse-Hinds).
- .3 Appleton.
- .4 Iberville.

.2 Epoxy Coated Outlet Boxes:

- .1 Columbex (Green Guard).

3. Execution

3.01 GENERAL INSTALLATION

- .1 Provide outlet box or back box for each luminaire, wiring device, telecommunications outlets, fire alarm system component, communications systems components and each other such outlet.
- .2 Each box is suitable in respects for application and complete with suitable securing lugs, connectors suitable for connected conduit, knockouts and, where necessary, suitable plaster rings, concrete rings, covers, carpet flanges and accessories.
- .3 Electrical boxes exposed exterior of building or in non-climate controlled locations are weatherproof and corrosion-resistant boxes complete with gasketed covers/faceplates.
- .4 Size boxes to accommodate intended applications and for bending radii of installed cables. Depending on location size boxes suiting thickness of floor slabs or depth of wall construction. Review requirements with respective system vendors. For telecommunications devices and cabling, refer to telecommunications systems specified in Division 27.
- .5 Outlet boxes flush mounted in interior construction, surface mounted in concealed interior locations, and surface mounted in exposed interior locations where connecting conduit is EMT: Stamped and galvanized steel outlet boxes.
- .6 Outlet boxes for surface mounted exterior lighting, receptacles, and other device outlets, boxes flush mounted in exterior building surfaces, and boxes mounted in interior device locations where connecting conduit is rigid and boxes in perimeter wall where insulation and vapour barrier is present, and boxes in non-climate-controlled areas: Type "FS" or "FD" Series cast boxes.
- .7 Outlet boxes in plastic conduit systems: Rigid PVC plastic outlet boxes.
- .8 Outlet boxes for flush floor mounted devices: Refer to Section 26 05 38 - Floor Boxes and Fittings.
- .9 Provide barriered outlet box for switches connected to normal and emergency power and sharing common faceplate.
- .10 Provide barriered boxes when boxes contain both power and communication outlets and different voltage levels.

- .11 Support boxes independently of connecting conduits.
- .12 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .13 For flush installations, mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .14 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .15 Provide outlet boxes for special wiring devices, for special equipment and special applications. Refer to requirements specified in other Sections, or as noted.
- .16 Size and arrangement of outlet boxes to suit device which they serve.
- .17 Mounting heights and locations for outlet boxes are typically indicated on drawings. Prior to roughing-in, review location and arrangement of outlets with Consultant. Architectural drawings and Consultant instructions have precedence over electrical drawing diagrammatic layouts and specified mounting heights and locations.
- .18 Do not install boxes "back-to-back" in walls and partitions. Stagger such boxes and seal against noise transmission. Through-wall type boxes are not permitted.
- .19 Properly support exterior mounted boxes for receptacles. Where location is not adjacent to structure or support indicated, provide rigid conduit support properly imbedded into ground and secure box at suitable required height. Prior to start of work, review exact installation requirements with Consultant.
- .20 Vacuum clean interior of boxes before installation of wiring devices.
- .21 Provide sealing around boxes in walls where insulation and vapour barrier is present, or for walls of rooms that are sealed. Wrap boxes in firestop putty shields. Maintain sealing system of wall. Coordinate with applicable requirements of Division 09.
- .22 Provide acoustic sealing around boxes as reviewed with Consultant.
- .23 Provide explosion-proof boxes and fittings suitable for hazardous location classifications of areas.
- .24 Provide blank coverplates over boxes left empty for future installation of devices. Clearly identify each box as to its intended use and reviewed with Consultant. Provide coverplates as follows:
 - .1 Temporary during construction: Impact-resistant plastic.
 - .2 Unfinished service areas equipment rooms: Galvanized steel.
 - .3 Public areas, front of house and finished areas: Stainless steel.
 - .4 On existing obsolete boxes which are to remain in position.
- .25 Inspect installed boxes verifying proper installation suiting installation surfaces.

3.02 IDENTIFICATION

- .1 Identification Labels: Size 2 indicating voltage and phase and system name, or as noted.
- .2 Identify systems for outlet boxes. Clearly identify system of boxes by painting outside of covers. Spray painting is not permitted unless approved by Owner and reviewed with Consultant. Provide paint colours in accordance with following schedule, as reviewed with Consultant:
 - .1 Lighting: Yellow.

- .2 Normal Power: Blue.
 - .3 Essential Power: Orange.
 - .4 Fire Alarm: Red.
 - .5 Telephone: Green.
 - .6 Miscellaneous Signals: Brown.
- .3 Where required by Owner, in addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 62-[93(R2022)], Surface Raceway Systems.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this section. Include:
 - .1 For each raceway type specified.
 - .2 Include specified components, accessories, and fittings.
- .3 Submit minimum 300 mm length samples of each type of raceway.
- .4 Submit testing and verification reports.

2. Products

2.01 SYSTEMS - GENERAL

- .1 Standards:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 In accordance with CSA C22.2 No. 62, unless otherwise noted.
- .2 Provide raceways of types noted suiting intended applications, complete with components, accessories, and fittings necessary for complete and finished installation.
- .3 In areas where multiple services are required, provide multi-channel raceways suiting intended applications. Where only single service is required, provide single channel type raceways. Review requirements with Consultant.
- .4 Coordinate and measure exact dimensions for lengths, to meet site installation. Where horizontal sections meet vertical sections, provide manufacturer connecting fitting for covering openings or exposed conductors. Comply with bending radii requirements of various cabling standards.
- .5 Provide wiring devices in accordance with Section 26 07 26 - Wiring Devices.
- .6 Coordinate requirements for telecommunications data/voice jacks and structured cabling with telecommunications cabling specialist trade responsible for work of Division 27. Size raceways suiting requirements of Division 27.
- .7 Provide cover plates to match raceway manufacturer standard cover and finishes.
- .8 Provide size of raceway as indicated and that does not exceed raceway manufacturer wire fill capacities of 40% fill, unless otherwise noted.

2.02 MULTI-OUTLET STRIP

- .1 Surface mounted, pre-wired multi-outlet strip system.
- .2 Channel Construction:
 - .1 No less than 1.0 mm thick steel.
 - .2 PVC.
 - .3 No less than 1.5 mm thick extruded aluminum.
- .3 Pre-wired Outlets Wired:
 - .1 Single circuit, 3-wire (1-hot, 1-neutral and 1-insulated ground).
 - .2 Two circuits, 4-wire (2-hot, 1-neutral and 1-insulated ground), outlets wired alternatively.
 - .3 Integral pre-wired power receptacles.
 - .4 Clips, couplings, brackets, fittings, elbows, boxes, tees and mounting hardware, for complete raceway system.

2.03 SURFACE METAL RACEWAY SYSTEM (SMALL CAPACITY WIRING PULLED IN)

- .1 One-piece raceway approximately 13 mm H x 19 mm W unless otherwise noted, single channel assembly, facilitating site pulled-in wiring.
- .2 No less than 1.0 mm thick steel, free of sharp edges.
- .3 Bushings, mounting straps, connection covers, corners, pull boxes, elbows, tees, and ancillary components, required for installation.
- .4 Switches, receptacles, device boxes, extension boxes, adapters and fittings, providing complete system.
- .5 Finish: Enamel of colour reviewed with Consultant.

2.04 SURFACE METAL RACEWAY SYSTEM (SMALL CAPACITY WIRING LAID IN)

- .1 Two-piece approximately 22 mm H x 48 mm W unless otherwise noted, single or two channels as noted, assembly to facilitate site laid-in wiring.
- .2 No less than 1.0 mm thick steel, free of sharp edges.
- .3 Snap on cover with base channel raceway, clips, couplings, covers, entrance end fittings, pull boxes, elbows, tees, and ancillary components, required for installation.
- .4 Two channels with dividers.
- .5 Switches, receptacles, device brackets and boxes, extension boxes, adapters and fittings, providing complete system.
- .6 Finish: Enamel of colour reviewed with Consultant.

2.05 SURFACE METAL RACEWAY SYSTEM (MEDIUM CAPACITY WIRING LAID IN)

- .1 Two-piece approximately 44 mm H x 120 mm W unless otherwise noted, single or two channels as noted, assembly to facilitate site laid-in wiring.
- .2 No less than 1.0 mm thick galvanized steel, free of sharp edges.
- .3 Snap on cover with base channel raceway, divider for channels, clips, couplings, covers, entrance end fittings, pull boxes, elbows, tees, and ancillary components, providing complete system.

- .4 Two channels with dividers.
- .5 Switches, receptacles, device brackets and boxes, extension boxes, adapters and fittings, providing complete system.
- .6 Finish: Enamel of colour reviewed with Consultant.

2.06 SURFACE METAL RACEWAY SYSTEM (LARGE CAPACITY WIRING LAID IN)

- .1 Two-piece, single or two channels as indicated, assembly to facilitate site laid-in wiring of approximately size of 90 mm H x 120 mm W.
- .2 No less than 1.0 mm thick galvanized steel, free of sharp edges.
- .3 Snap on cover with base channel raceway, divider for channels, clips, couplings, covers, entrance end fittings, pull boxes, elbows, tees, and ancillary components, providing complete system.
- .4 Two channels with dividers.
- .5 Switches, receptacles, device brackets and boxes, extension boxes, adapters and fittings, providing complete system.
- .6 Finish: Enamel of colour reviewed with Consultant.

2.07 SURFACE ALUMINUM RACEWAY SYSTEM

- .1 Two-piece, single, dual or triple channels as indicated, assembly to facilitate site laid-in wiring of following approximate sizes:
 - .1 Single Channel: 44 mm H x 65 mm W.
 - .2 Two Channels: 44 mm H x 120 mm W.
 - .3 Triple Channels: 44 mm H x 185 mm W.
- .2 No less than 1.9 mm thick aluminum, free of sharp edges.
- .3 Snap on cover with base channel raceway, clips, couplings, covers, entrance end fittings, pull boxes, elbows, tees, and ancillary components, required for installation.
- .4 Multi-channel with dividers.
- .5 Switches, receptacles, device brackets and boxes, extension boxes, adapters and fittings, providing complete system.
- .6 Finish: Enamel of colour reviewed with Consultant.

2.08 OVER FLOOR RACEWAY SYSTEM

- .1 Two-piece approximately sloped 11 mm H x 150 mm W, 4 channels, assembly to facilitate site laid-in wiring for multiple power and communication services.
- .2 No less than 1.0 mm thick steel cover, no less than 2.0 mm aluminum channel divided into 4 channels, free of sharp edges.
- .3 Clips, couplings, end fittings, transitions, elbows, and ancillary components, providing complete system.
- .4 Receptacles, device brackets and device boxes, and fittings, providing complete system.
- .5 Finish: Black powder coat finish, as reviewed with Consultant.

2.09 LOW PROFILE SURFACE FLOOR RACEWAY SYSTEMS

- .1 Low profile, surface floor-based power and data distribution system that allows users to add connectivity or change power locations in a snap.
- .2 System includes:
 - .1 Entrance fittings:
 - .1 Quick connectors that power entire raceway by converting building main power to four-circuit power system.
 - .2 Fabricated from PC plastic and galvanized steel.
 - .3 In-wall:
 - .1 Attached to pre-wired flexible steel conduit that includes 1/2-inch knockout fitting.
 - .2 Base trim: Fabricated from PC plastic and covers hole in wall and is placed at entrance of raceway.
 - .3 Connects to junction box in wall or ceiling with:
 - .1 4.5 m of pre-wired conduit.
 - .4 Surface-mounted wall track starts at wall:
 - .1 Attached to pre-wired flexible steel conduit that includes 1/2-inch knockout fitting.
 - .2 Connects to junction box in wall or ceiling.
 - .3 Includes wall channel kit that encases conduit in aluminum extrusion and transition accessories.
 - .4 Includes:
 - .1 4.5 m of pre-wired conduit, 3.6 m wall track.
 - .2 Raceways:
 - .1 Low profile, fabricated from PC plastic and galvanized steel.
 - .2 Pre-wired raceway segments paired with top covers and transition ramps to make complete system.
 - .3 Power tracks have modular connectors on each end that snap into entrance fitting, power track extender, power track corner, power hub, or power end hub to assemble raceway.
 - .4 Lengths to suit intended applications.
 - .5 Finishes: Silver or dark gray as reviewed with Consultant.
 - .6 Track extenders.
 - .7 Track corners.
 - .8 Aluminum top covers.
 - .9 MDF transition ramps
 - .10 End ramps.
 - .3 Power Devices:
 - .1 Interchangeable.
 - .2 Power Hubs and end hubs:
 - .3 Fabricated from PC plastic.
 - .4 Connect tracks and provides access for power devices.
 - .5 Includes modular connectors on each end that snap into power track or power track extender to assemble raceway.
 - .4 Data Devices:
 - .1 Fits up to 8 low voltage keystone modules.

- .2 Provide data/voice jacks and wiring as coordinated with telecommunications network cabling specialist trade responsible for provision of telecommunication system components and wiring.
- .5 Power Devices:
 - .1 Receptacles: Pre-wired quad, NEMA 5-20R, 125 VAC, and various circuit options up to 4 circuits.
 - .2 Hubcap: Covers.
 - .3 Hardwire device: 4-circuit box connects to furniture base feeds.
 - .4 Grommets: Allows cables to enter and exit raceways.
- .6 System Spare Capacity: Include with system, spare 20% capacity for future circuits and devices.

2.10 NON-METALLIC PLASTIC RACEWAY (SMALL CAPACITY WIRING PULLED IN)

- .1 One-piece, latching, single channel, assembly to facilitate site laid-in wiring of following approximate sizes:
 - .1 12 mm H x 20 mm W.
 - .2 16 mm H x 29 mm W.
 - .3 20 mm H x 43 mm W.
- .2 PVC channel with co-extruded hinge and adhesive backing.
- .3 Clips, couplings, entrance end fittings, elbows, tees, and ancillary components, providing complete system.
- .4 Switches, receptacles, device brackets and boxes, extension boxes, adapters and fittings, providing complete system.
- .5 Finish: Enamel of colour reviewed with Consultant.

2.11 NON-METALLIC PLASTIC RACEWAY (MEDIUM/LARGE CAPACITY WIRING PULLED IN)

- .1 Two-piece single, 2 or 3 channels as indicated, assembly to facilitate site laid-in wiring of following approximate sizes:
 - .1 Single Channel: 11 mm H x 22 mm W.
 - .2 Single Channel: 17 mm H x 57 mm W.
 - .3 Two Channels: 17 mm H x 57 mm W.
 - .4 Two Channels: 44 mm H x 130 mm W.
 - .5 Triple Channels: 44 mm H x 170 mm W.
- .2 Channel of textured ridged extruded polyvinyl chloride (PVC) construction with solid snap-on cover throughout entire length.
- .3 Snap on cover with base channel raceway, divider for multi-channels, clips, couplings, entrance end fittings, elbows, tees, and ancillary components, providing complete system.
- .4 Switches, receptacles, device brackets and boxes, extension boxes, adapters and fittings, providing complete system.
- .5 Finish: Enamel of colour as reviewed with Consultant.

2.12 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Surface Raceways and Multi-Outlet Strips:
 - .1 Legrand (Wiremold).
 - .2 ABB (T&B).
 - .3 Hubbell.
 - .4 Niedax Canadian Electrical Raceways.
- .2 Low Profile Surface Floor Raceway Systems:
 - .1 Legrand (Connectrac).

3. Execution

3.01 INSTALLATION OF SURFACE RACEWAYS

- .1 Provide surface mounted raceway assemblies complete with accessories necessary for complete electrical raceway system. Site measure for proper lengths. Provide required type and quantity of receptacles. Prior to ordering, review with Consultant, exact types for each application and review finishes.
- .2 Obtain required training from manufacturer representative on special installation procedures. Install raceways in accordance with manufacturer instructions, suiting intended installation requirements. Use manufacturer recommended tools for cutting and installing raceways.
- .3 Assemble and secure raceways, boxes and other components to surfaces in accordance with manufacturer instructions and requirements. Locate vertical runs of raceway in corners and inconspicuous locations. Where possible butt raceway ends to adjacent walls, cabinets, counters, and other fixtures. Run raceways parallel to floor/ceiling planes as applicable. Where raceway is attached to equipment or sections of millwork, install raceway for full length of equipment/millwork, or as indicated. Mount faceplates flush to raceway with no gaps. Do not exceed wire fill requirements given in manufacturer instructions.
- .4 Provide barriers for systems with different voltages in raceway.
- .5 Install supports, elbows, tees, connectors, fittings, bushings, adaptors as required.
- .6 Maintain number of elbows, offsets and connections to minimum.
- .7 Install surface raceway continuous around corners. Provide corner and vertical sections.
- .8 Use wiring with mechanical protection in channel raceways. Fasten wiring with wire clips inside raceway.
- .9 Install wiring after installation of raceway system is complete.
- .10 Install wiring devices and cover plates.
- .11 Review installation requirements of telecommunications cabling and jacks with Division 27 telecommunications cabling system vendor. Provide raceways suitable for and in accordance with standard for telecommunication jacks and cabling. Provide device mounting brackets, suiting final modular jack being installed.

3.02 INSTALLATION OF LOW PROFILE SURFACE FLOOR RACEWAY SYSTEMS

- .1 Engage manufacturer representative to prepare installation drawings.
- .2 Examine conditions under which raceway systems are installed. Notify Consultant of conditions detrimental to proper completion of work.

- .3 Assemble and secure raceways and accessories to surfaces in accordance with manufacturer instructions and requirements. Unless otherwise noted, run raceways parallel to wall planes as applicable.
- .4 Refer to drawings for locations and types of entrance fittings, tracks and devices.
- .5 Coordinate installation with adjacent work ensuring proper clearances and to prevent electrical hazards.
- .6 Provide power devices, data devices and circuits to accommodate devices reflected on drawings. Do not overload circuits.
- .7 Provide accessories to complete track raceway system installation.
- .8 Do not penetrate floor.
- .9 Coordinate requirements with structured cabling system vendor to ensure that raceways are suitable for and comply with standard for telecommunication jacks and cabling. Ensure that device mounting brackets are co-ordinated to suit final modular jack being installed.
- .10 Prior to ordering, review finishes with Consultant.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing and Verification:
 - .1 Inspect, test and verify operation of products.
 - .2 Inspect and test connections and components.
 - .3 Coordinate testing of wiring devices with requirements of Section 26 07 26 - Wiring Devices.
 - .4 Coordinate testing of telecommunication jacks and wiring with respective telecommunications and AV system vendors.
- .2 Prepare testing and verification report signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA A23.1-[24]/CSA A23.2-[24], Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CSA C22.2 No. 18.3-[12(R2022)], Conduit, Tubing, and Cable Fittings (Tri-national standard, with ANCE NMX-J-017 and UL 514B).
 - .3 CSA C22.2 No. 18.4-[15(R2019)], Hardware for the Support of Conduit, Tubing, and Cable (Bi-national standard with UL 2239).
 - .4 CSA C22.2 No. 45.1-[22], Electrical Rigid Metal Conduit - Steel
 - .5 (Tri-National standard, with UL 6 and NMX-J-534-ANCE-2007).
 - .6 CSA C22.2 No. 56-[17(R2022)], Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .7 CSA C22.2 No. 83.1-[07(R2022)], Electrical Metallic Tubing - Steel (Tri-National Standard, with UL 797 and NMX-J-536-ANCE-2007).
 - .8 CSA C22.2 No. 85-[14(R2023)], Rigid PVC Boxes and Fittings.
 - .9 CSA C22.2 No. 211.2-[06(R2021)], Rigid PVC (Unplasticized) Conduit.
 - .10 CSA C22.2 No. 211.3-[96(R2007)], Reinforced Thermosetting Resin Conduit (RTRC) and Fittings (Bi-National standard, with UL 1684).
 - .11 CSA C22.2 No. 227.1-[19(R2023)], Electrical Nonmetallic Tubing (Binational standard with UL 1653).
 - .12 CSA C22.2 No. 327-[18(R2023)], HDPE Conduit, Conductors-in-Conduit, and Fittings.
- .2 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA TC 14-[2015] Series, Reinforced Thermosetting Resin Conduit and Fittings Series.
- .3 Underwriter Laboratories (UL):
 - .1 UL 2515-[2022], Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.02 SUBMITTALS

- .1 Product Data and Shop Drawings:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Submit for:
 - .1 Epoxy coated industrial corrosive resistant conduits, boxes and fittings.
 - .2 Flexible metal liquid-type conduits, boxes and fittings.
 - .3 Fibreglass conduits, conduit bodies and fittings.
 - .4 Explosion-proof boxes and fittings.

2. Products

2.01 CONDUITS

- .1 Rigid Metal Conduit (RMC) or Rigid Galvanized Steel (RGS):
 - .1 In accordance with CSA C22.2 No. 45.1.
 - .2 Exterior zinc and interior enamel coatings, galvanized threads where factory cut and red lead coated threads where site cut.
 - .3 Factory made bends where site bending is not possible.
 - .4 Factory made and threaded steel fittings.
 - .5 Connectors and terminations with rigid steel couplings, concrete tight where run in concrete.
- .2 Electrical Metallic Tubing (EMT):
 - .1 In accordance with CSA C22.2 No. 83.1.
 - .2 Factory made bends where site bending is not possible.
 - .3 Joints and terminations made with steel couplers and steel set-screw or compression type connectors with insulated throats.
 - .4 Set-screws for EMT conduits are not acceptable except for applications in accessible ceiling spaces, office shafts or tight spaces where compression connectors cannot be used.
 - .5 Raintight steel compression type connectors: Where EMT located in sprinklered areas, service areas, service shafts, elevator shafts and service tunnels.
- .3 Flexible Metal Liquidtight Conduit:
 - .1 In accordance with CSA C22.2 No. 56.
 - .2 Hot dipped zinc galvanized steel core inside and outside.
 - .3 Outer flame-retardant thermoplastic jacket.
 - .4 Liquid-tight, gasketed flexible conduit connectors at terminations.
 - .5 Suitable for wet locations.
- .4 Galvanized Steel Flexible Metallic Conduit:
 - .1 In accordance with CSA C22.2 No. 56.
 - .2 Galvanized steel core inside and outside.
 - .3 Proper and suitable squeeze type connectors at terminations.
- .5 Rigid PVC Conduit:
 - .1 In accordance with CSA C22.2 No. 211.2.
 - .2 FT-4 rated, rigid plastic.
 - .3 Site made heat gun bends on conduit to 50 mm diameter.
 - .4 Factory made elbows in conduit larger than 50 mm diameter.
 - .5 Solvent weld joints.
 - .6 Factory made expansion joints.
 - .7 Terminations made with proper and suitable connectors and adaptors.
- .6 Polyethylene (PE) Flexible Plastic Conduit:
 - .1 CSA certified.
 - .2 Medium density.

- .3 Smooth interior for easy wire pulling.
- .4 UV sunlight resistant jacket.
- .5 Rated for temperature range of minus 30°C to 80°C.
- .6 In continuous coil.
- .7 High Density Polyethylene (HDPE) Flexible Plastic Conduit:
 - .1 CSA certified to CSA C22.2 No. 327.
 - .2 Manufactured from HDPE resin.
 - .3 Internal longitudinal ribbing and low co-efficient of friction inner wall lining eliminates need for wet lubricants.
 - .4 Rated for temperature range of minus 34°C to 82°C.
 - .5 In continuous coil.
 - .6 With pull tape and tracer wire.
- .8 Fibreglass Conduit (Above Ground):
 - .1 Above ground conduits in accordance with CSA-22.2 No 211.3 and UL 2515.
 - .2 Flame-resistant, features characteristics of low-smoke, lightweight, non-corrosive, non-toxic, impact-resistant and flexibility.
 - .3 Halogen-free additives for increasing flame spread and lowering smoke density.
 - .4 Coefficient of friction lower than that of steel and PVC.
 - .5 Operating temperatures: Minus 40°C to 110°C.
 - .6 Reinforced thermosetting resin conduit (RTRC), manufactured using single circuit filament winding process.
 - .7 Resin system: Epoxy based, with no fillers, using anhydride curing agent.
 - .8 Fibreglass consists of continuous E-glass Grade "A" roving.
 - .9 Carbon black used as ultra violet inhibitor protecting conduit and fittings during storage and exposure to outdoors.
 - .10 Conduit and elbows: Black in colour.
 - .11 Internal conduit and elbow walls: Smooth and fibers embedded in epoxy.
 - .12 Identification markings: Conduits and elbows durably and legibly marked in accordance to NEMA TC 14.
 - .13 Conduit bodies:
 - .1 Made from compression moulded, halogen-free, self-extinguishing vinyl ester reinforced fibreglass.
 - .2 Water-tight seal between cover and conduit body and is supplied with 316 stainless steel hardware cover screws.
 - .3 Silicone based, water-tight and corrosion-resistant gasketing.

2.02 CONDUIT FASTENINGS

- .1 In accordance with CSA C22.2 No. 18.4 and manufactured for use with conduit specified.
- .2 One-hole steel straps to secure surface conduits 50 mm and smaller.
- .3 Two-hole steel straps for conduits larger than 50 mm.
- .4 Beam clamps to secure conduits to exposed steel work.
- .5 Channel type supports for two or more conduits at suitable spacing to support weight of entire assembly.

- .6 Threaded rods, minimum 6 mm diameter or greater, to support suspended channels.

2.03 CONDUIT FITTINGS

- .1 In accordance with CSA C22.2 No. 18.3 and manufactured for use with conduit specified.
- .2 Coating: Same as conduit.
- .3 Factory "ells" for 90 degrees bends of 25 mm and larger conduits.
- .4 Concrete tight where embedded in concrete.

2.04 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 In accordance with CSA C22.2 No. 18.3 and manufactured for use with conduit specified.
- .2 Coating: Same as conduit.
- .3 Weatherproof expansion fittings with internal bonding assembly suitable for 200 mm linear expansion.
- .4 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .5 Weatherproof expansion fittings for linear expansion at entry to panel.

2.05 EXPLOSION-PROOF FITTINGS

- .1 Explosion-Proof Elbows:
 - .1 Installed in conduit systems within hazardous areas to:
 - .1 Used to make 90 degree bends in thread conduit systems.
 - .2 Act as pull outlets.
 - .3 Provide access to conductors for maintenance and future changes.
 - .2 Features:
 - .1 Construction (depending on size and suiting intended applications):
 - .1 Feraloy iron alloy.
 - .2 Copper-free aluminum.
 - .3 Finish: Electro-galvanized.
 - .2 Taper threaded hubs for ground continuity.
 - .3 Smooth integral hub bushings protecting conductor insulation when pulling.
 - .4 Multi-different hub arrangements suiting intended applications.
 - .5 Machined body with blind tapped screw holes.
 - .6 Suitable for raintight and wet location areas.
- .2 Explosion-Proof Flexible Couplings:
 - .1 Used to achieve tight bends in conduit systems in confined spaces and to connect stationary equipment that may see movement or vibration.
 - .2 Depending on size, made from flexible bronze or stainless steel construction with arc-resistant inner sleeve and brass or stainless steel fittings.
 - .3 Male nipples with NPT taper threads on each end.
 - .4 Not require bonding jumper.
 - .5 Suitable for raintight and wet location areas.

- .3 Explosion-Proof Couplings (Unions):
 - .1 3-piece couplings used to connect elements between enclosures, fittings or boxes that permit future changes to system.
 - .2 Suitable for raintight and wet location areas.
 - .3 Types:
 - .1 Male and female unions connecting conduit to conduit fittings.
 - .2 Female to female unions.
 - .3 Male to female unions.
 - .4 Construction (depending on size and suiting intended applications):
 - .1 Steel with electro-galvanizing and chromate finish, or malleable iron with electro-galvanizing and aluminum acrylic paint.
 - .2 Copper-free aluminum with lacquer finish.
 - .5 NPT tapered threads for used with threaded rigid metal conduits.
- .4 Explosion-Proof Sealing Fittings:
 - .1 Used on sections of conduit runs restricting passage of gases, vapors or flames from one portion of electrical installation to another, limiting explosions to sealed off enclosures, and limiting pre-compression or pressure piling in conduit systems.
 - .2 Drain seal covering hubs either vertical or horizontal applications.
 - .3 Construction (depending on size and suiting intended applications):
 - .1 Copper-free aluminum used in either vertical or horizontal applications.
 - .2 Gray iron or ductile iron with electro-galvanized and aluminum acrylic paint finish.
 - .3 Stainless steel drain type providing continuous, automatic draining of condensation.
 - .4 Tapered NPT threads for use with threaded rigid metal conduits.
 - .5 Used with sealing cement and packing fiber suiting intended applications.
 - .6 Suitable for raintight and wet location areas.

2.06 PULL CORDS

- .1 Unless otherwise noted, synthetic polypropylene fibre (plastic) twine cord, at least 6 mm or greater diameter, supporting pulling of cables.
- .2 Refer to Division 27 for pull cord requirements related to telecommunications work.
- .3 Approved by electrical utility, where required.

2.07 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Epoxy Coated Conduits:
 - .1 Columbex (Green Guard).
- .2 Fibreglass Conduits:
 - .1 Champion.
 - .2 Atkore.
 - .3 United Fiberglass.

3. Execution

3.01 GENERAL INSTALLATION REQUIREMENTS

- .1 Refer to and examine architectural drawings and room finish schedules to determine finished, partially finished or unfinished areas of building. Documents do not identify exact routing. Where shown, routing is diagrammatic, identifying general requirements of routing and locations. Include for necessary offsets, fittings, transformations and similar items required as result of obstructions and other architectural or structural details not shown.
- .2 Install conduit concealed in finished areas, and concealed to degree made possible by finishes in partially finished and unfinished areas. Run parallel or perpendicular to building lines. Do not install horizontal runs in masonry walls. Do not install conduits in terrazzo or concrete toppings.
- .3 Surface Conduits:
 - .1 Run conduits exposed in unfinished interior areas such as Electrical and Mechanical Rooms, unless otherwise noted.
 - .2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass. Run parallel or perpendicular to building lines. Arrange them to avoid interference with other work and install as high as possible.
 - .3 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
 - .4 Run conduits in flanged portion of structural steel.
 - .5 Group conduits wherever possible on suspended or surface metal channels.
 - .6 Do not pass conduits through structural members except as noted.
 - .7 When running conduit, maintain clearance of at least 150 mm where conduit runs parallel to steam or hot water lines with at least 50 mm clearance at crossovers.
 - .8 Do not run conduits within 900 mm of equipment access opening covers.
 - .9 Support conduit runs from wall or ceiling structure, not from ceiling hangers, ductwork, piping, cable trays, formed steel decking, and other elements secured to wall or ceiling.
- .4 Conduit Embedded in Concrete:
 - .1 Install sleeves prior to pouring of concrete.
 - .2 Install conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.
- .5 Areas with Raised Floors:
 - .1 Install EMT conduit from branch circuit panel to outlet boxes or junction boxes located in sub floor.
 - .2 Run flexible liquidtight conduit from junction box to outlet boxes in sub-floor, as noted.
- .6 Provide conduit sized as noted. Size conduit that is not sized, in accordance with local governing electrical code. Additionally, indicated sizes of conductors are minimum sizes, and require increasing to suit length of run and voltage drop, in accordance with electrical code voltage drop requirements. Increase conductor sizes suiting voltage drop requirements and increase conduit size to suit.
- .7 Provide conduit for power or lighting circuits, of size no smaller than 19 mm diameter, unless otherwise noted.

- .8 Where conduit is proposed for embedding within structural concrete, review with Consultant and obtain recommendation from Consultant. Install such conduit in accordance with requirements of CSA A23.1/CSA A23.2.
- .9 For conduit cast in concrete at floors-on-ground, additionally include:
 - .1 Running conduits 25 mm and larger, below slab and encasing in 75 mm concrete envelope.
 - .2 Providing 50 mm of sand over concrete envelope below floor slab.
- .10 For conduit runs underground below slab include following provisions:
 - .1 Concrete encased ductbank with conduits of non-ferrous materials and sloped to drain properly into pit.
 - .2 Drain pit.
 - .3 Pull-in system.
 - .4 20% spare conduits (with minimum of at least 1).
 - .5 System proposal to consider and address effects of magnetic fields.
 - .6 Refer to details on drawings.
 - .7 Refer to requirements of Division 33.
 - .8 Refer to requirements of Section 26 05 43 - Installation of Cables in Trenches and Ducts.

3.02 INSTALLATION OF CONDUIT

- .1 Provide conduit for conductors except armoured cable and copper sheathed mineral insulated conductors, and except where duct or similar raceway materials are provided.
- .2 Provide conduit as follows:
 - .1 For interior building surface mounted conductors greater than 600 V: Rigid galvanized steel.
 - .2 For conductors exceeding 600 V for main distribution wiring in Electrical rooms, and for concealed conduit in exterior walls: Rigid galvanized steel.
 - .3 For exposed conduit outside building, for semi-exterior areas such as loading areas: Rigid galvanized steel (rigid PVC where permitted by local codes and recommended by Consultant).
 - .4 For exposed conduit in non-climate-controlled areas, in areas of corrosive elements: Epoxy coated rigid steel.
 - .5 For branch circuit conductors underground inside building, and underground outside building beneath concrete, asphalt, and similar paving material: Rigid PVC.
 - .6 For branch circuit conductors underground outside building clear of concrete, asphalt and similar paving material: Flexible polyethylene or high density polyethylene plastic conduit, as noted on drawings.
 - .7 For exposed conduit mounted at height of less than 1200 mm in electrical, mechanical or other service areas, and for areas subject to mechanical injury: Rigid galvanized steel.
 - .8 For short branch circuit connectors to motorized equipment and distribution transformers (minimum length 450 mm, maximum length 600 mm with 180° loop where possible): Galvanized steel flexible liquid-tight conduit.
 - .9 At points, where conductors cross building expansion joints: Galvanized steel flexible conduit with no less than 600 mm of extra curve.

- .10 For branch circuit conductors in poured concrete slab: Rigid PVC.
- .11 For interior conduit above 50 mm diameter containing distribution conductors or communication systems conductors (fire alarm, telephone, security, telecom) (except as noted above): EMT with separate insulated ground conductor.
- .12 For conductors unless otherwise noted above or elsewhere in Specification: EMT.
- .3 Run rigid conductors in rigid type conduits suitable for application. Do not use flexible conduit.
- .4 Provide manufactured expansion joints in rigid PVC plastic conduit at spacing as recommended by conduit manufacturer.
- .5 Provide separate ground conductor in plastic conduits.
- .6 Install flexible PE or HDPE conduits with bending radii in accordance with manufacturer instructions and joined using fusion methods or mechanical non-weld couplings approved by conduit manufacturer and AHJ.
- .7 Support and secure surface mounted and suspended single or double runs of metal conduit at support spacing in accordance with electrical code requirements by means of galvanized pipe straps, conduit clips, ringbolt type hangers, or by other suitable manufactured devices.
- .8 Support multiple mixed size metal conduit runs with conduit racks spaced to suit spacing requirements of smallest conduit in group.
- .9 Provide conduit fittings constructed of same materials as conduit and suiting intended application.
- .10 Provide adaptors for joining conduits of different materials.
- .11 Provide explosion-proof boxes and fittings for explosion-proof designated work as noted.
- .12 Install explosion proof flexible connection for connection to explosion proof motors.
- .13 Install conduit sealing fittings in hazardous areas. Fill with compound to seal openings.
- .14 Cut square and properly ream site cut conduit ends such that field threads on rigid conduit are of sufficient length to draw conduits up tight.
- .15 Provide epoxy coated boxes and fittings for epoxy coated conduit. Handle, install and thread epoxy-coated conduit system in accordance with manufacturer instructions as not to damage epoxy-coating. Seal joints with manufacturer sealing compound.
- .16 Site made bends for conduit to maintain full conduit diameter with no kinking, and conduit finishes to not flake or crack when conduit is bent. Bend conduit cold. Replace conduit kinked or flattened more than 1/10th of its original diameter. Mechanically bend steel conduit over 19 mm diameter.
- .17 Plug ends of roughed-in conduits which are exposed during construction with suitable plugs.
- .18 Clean, clear, cap and properly identify at each termination point, conduit systems left empty for future wiring. Provide end bushing and suitable pull cords in such conduits.
- .19 Run 2 - 25 mm spare conduits up to ceiling space and 2 - 25 mm spare conduits down to ceiling space of floor below from each flush panelboard. Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of exposed concrete slab, terminate each conduit in flush or surface concrete type box. Install fish cords in conduits.
- .20 Install pull cords in conduits sized for future conductors as noted.

- .21 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .22 Dry conduits out before installing wire.

3.03 CONDUITS IN CAST-IN-PLACE CONCRETE

- .1 Where conduit is proposed for embedding within concrete, review with Consultant and obtain recommendation from Consultant. Install such conduit in accordance with CSA A23.1/CSA A23.2.
- .2 Secure conduit located in poured concrete work in place in manner such that conduit does not float or move when concrete is poured. Protect such conduit from damage prior to and during concrete pour, and from concrete and water penetration. Install rigid PVC type conduit.
- .3 Prior to Start of Work, review with Consultant, maximum allowable size of conduit for installation in poured concrete.
- .4 Placement of reinforcing steel in structural concrete work takes precedence over placement of conduit.
- .5 Space multiple runs of conduit in poured concrete work at least three diameters or width on center, as reviewed with and recommended by Consultant.
- .6 Do not run conduits in slabs where slab thickness is not at least 4 times conduit diameter.
- .7 Locate suiting reinforcing steel.
- .8 Install in centre one third of slab.
- .9 Protect conduits from damage where they stub out of concrete.
- .10 Install sleeves where conduits pass through slab or wall.
- .11 Prior to installation of waterproof membranes, install oversized sleeve for conduits passing through membrane. Coordinate with waterproofing work of Division 07.
- .12 Use cold mastic between sleeve and conduit.
- .13 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .14 Organize conduits in slab to minimize crossovers.
- .15 Conduit cast in concrete at floors-on-ground, additionally include:
 - .1 Running conduits 25 mm and larger, below slab and encasing in 75 mm concrete envelope.
 - .2 Providing 50 mm of sand over concrete envelope below floor slab.
- .16 For installation of ducts in concrete ductbanks, refer to Section 26 05 43 - Installation of Cable in Trenches and Ducts, or requirements of Division 33.

3.04 FIELD QUALITY CONTROL

- .1 Inspection and Verification:
 - .1 Inspect and verify product installations.
 - .2 Check connections and operations.
 - .3 Check for manufacturer proper markings of conduits, boxes and fittings.
- .2 Prepare verification reports, signed by technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 18.1-[13(R2023)], Metallic Outlet Boxes (Tri-national Standard, with UL 514A and ANCE NMX- J-023/1).
 - .2 CSA C22.2 No. 80-[16(R2021)], Underfloor Raceways and Fittings.
- .2 Underwriters Laboratories (UL):
 - .1 ANSI/UL 514A-[2022], Standard for Metallic Outlet Boxes.
 - .2 ANSI/UL 884-[2020], Standard for Underfloor Raceways and Fittings.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings
 - .1 Submit shop drawings for products of this Section. Include:
 - .1 Detailed layout of system showing coordinated layout of underfloor raceways.
 - .2 Raceway shapes and dimensions
 - .3 Types of presets, boxes, receptacles and accessories.
 - .4 Instructions and details for installation.
- .3 Submit samples of proposed duct, junction box, and activation kit.
- .4 Submit testing and verification reports.

2. Products

2.01 UNDERFLOOR DUCT SYSTEMS

- .1 General:
 - .1 CSA certified, and ULC listed and labeled.
 - .2 Consisting of multiple cells, feeder ducts, distribution ducts, junction assemblies, presets, aftersets, floor service fittings, end closures, termination facilities, supports and ancillary hardware, in accordance with:
 - .1 CSA C22.2 No. 80.
 - .2 CSA C22.2 No. 18.1.
 - .3 ANSI/UL 514A listing for scrub water exclusion test.
 - .4 Rating standards for telecommunications wiring run requirements. Refer to requirements of Division 27.

- .3 Components provided from same manufacturer and suitable for type of floor installed.
- .4 Typical modules consist of multiple cells for feeder and distribution ducts, providing power, telephone, and data services. Review required minimum sizing of each cell with Consultant. Cells are contiguous, with complete isolation between services.
- .2 Ducts:
 - .1 Duct system accommodates installation of power wiring and telecommunications cabling, copper and fiber optic cabling, and connections in flush service fittings.
 - .2 Preset provides maximum cable performance and cable loop storage. Flush service fittings provide bend radius features at workstation.
 - .3 Factory-installed presets permit conduit, partition, and other feeds directly out of preset.
 - .4 System features controlled bend radius at every turning point to maintain integrity of communication cable installations.
 - .5 Duct sizing as follows:
 - .1 Feeder (small): Outside dimensions of 79 mm W x 32 mm D with interior cross-sectional area of 2155 mm².
 - .2 Distribution (large): Outside dimensions of 165 mm W x 38 mm D with interior cross-sectional area of 5626 mm².
 - .6 Duct is one-piece continuous weld construction, in galvanized steel. Provide stainless steel duct for buried applications. Weld is continuous and on side of duct so as not to impede drilling for aftersets.
- .3 Presets And Accessories:
 - .1 Small Round Presets:
 - .1 Zinc die-cast components mounted 300 mm or 600 mm on center of duct as standard, or with custom spacing, as noted.
 - .2 Presets mounted minimum of 22 mm over top of duct, or in accordance with system manufacturer instructions, suiting intended applications.
 - .3 Round inserts diameter of 50 mm and capable of housing two 50 mm conduit, with beveled base expanded into duct forming continuous passageway, and with removable steel cap recessed to receive concrete.
 - .2 Large Presets (Provides large access area into duct):
 - .1 Zinc die-cast components mounted 300 mm or 600 mm on center of duct as standard, unless otherwise noted with custom spacing.
 - .2 Presets mounted minimum of 25 mm over top of duct for pedestal style fittings or when cabling is pulled through activation point, or in accordance with system manufacturer instructions, suiting intended applications.
 - .3 Minimum 38 mm preset as required to support standard duplex receptacles and communication devices when using flush activations.
 - .4 Presets sealed with recessed removable mud caps to receive concrete.
 - .5 Preset dimensions of 105 mm W x 123 mm L.
 - .6 Preset base is expanded into duct, forming continuous passageway.
 - .3 Preset Extensions: Die-cast construction, attaches to presets with push on metal sleeves; factory or field installed as noted. 25 mm size is stackable.

- .4 Mud Caps: Steel replacement cap for preset, suiting intended applications. Recessed holding required depth of concrete.
- .5 Marker Caps: Replaces mud cap on preset, indicating location of last insert in each run. Red or green colour as suitable for type of service run in duct.
- .4 Aftersets:
 - .1 Aftersets accept activations to support standard duplex receptacles and communication devices when using flush activations.
 - .2 Aftersets mounted minimum of 25 mm over top of duct for pedestal style fittings or when cabling is pulled through activation point, or in accordance with system manufacturer instructions, suiting intended applications.
 - .3 Installed either before or after concrete pour in accordance with manufacturer instructions suiting intended applications, creating activation from duct.
 - .4 Attaches to duct with locking tabs. Height increased by use of extensions.
 - .5 Aftersets are gangable and include alignment clips and mud caps.
- .5 Duct Conduit Hub:
 - .1 300 mm section of duct with 25 mm preset for rigid steel or PVC conduit.
 - .2 Provides feed to isolated outlets.
 - .3 Maintains 600 mm spacing of presets.
 - .4 Additional extensions are attached for higher presets.
- .6 Adjustable Duct Supports with Built-In Couplings:
 - .1 Steel construction with various leg heights.
 - .2 Provided with leveling screws for adjustment of height.
 - .3 Used to support, couple, and hold duct in place before and during concrete pour.
 - .4 Top members maintain 25 mm spacing between ducts.
 - .5 Duct supports located on approximately 1.5 m intervals.
- .7 Single Level Junction Boxes:
 - .1 Heavy duty junction boxes with internal supports to withstand minimum 136 kgs concentrated load, in accordance with ANSI/UL 884.
 - .2 Have openings on four sides for duct connections and on four corners for conduit adapters.
 - .3 Duct and conduit connections grounded.
 - .4 Junction boxes provide for minimum 32 mm bend radius of cables inside box.
 - .5 Includes parts necessary to extend height of each junction box as required by floor treatments.
 - .6 Square access opening.
- .8 Access Cover Plates:
 - .1 Minimum 9.5 mm thick.
 - .2 With inside terrazzo holder ring, suiting intended applications.
- .9 Service Fittings:
 - .1 Flush Rectangular Activation Service Fittings:
 - .1 Single, double and three gang, rectangular, brass construction, suiting intended applications.

- .2 UL scrub water tested.
- .3 Carpet and tile flange, suiting intended applications.
- .4 Flip lid cover plates for access to devices.
- .5 Duplex power receptacles and communication outlet provisions, as noted.
- .6 Conduit trim plates, matching fittings, as reviewed with Consultant.
- .2 Flush Round Activation Service Fittings:
 - .1 Approximately 180 mm round, quad power and communication fitting as noted, die cast aluminum construction.
 - .2 UL scrub water tested.
 - .3 Slide covers, gasketing, flanges, adapter brackets and link straps.
 - .4 Power receptacles and communication outlet provisions, as noted.
 - .5 Furniture feed fittings suiting intended applications.
- .3 Surface Pedestal Activation Service Fittings:
 - .1 Pedestal type, single gang, four-piece fittings with one or two sides of activation as noted, brushed aluminum construction, suiting intended applications.
 - .2 Single or duplex power receptacles and communication outlet provisions, as noted.
 - .3 Conduit trim plates, match fittings, as reviewed with Consultant.
- .4 Surface Multiplex Activation Service Fittings:
 - .1 Angular pedestal type, multiple service large capacity, multi-gang fittings with two sides of activation, brushed aluminum construction, suiting intended applications.
 - .2 Duplex power receptacles and communication outlet provisions, as noted.
 - .3 Flanged outlet plates as reviewed with Consultant.
- .10 Miscellaneous:
 - .1 Provide parts to transition from presets to service fittings. Provide furniture feed activation outlets and covers.
 - .2 Flanges: ULC listed for use on carpet, tile, or wood covered floor applications and accommodate workstation connectivity outlets and modular inserts. Modular inserts snap directly into each flange through use of mounting bezel.
 - .3 Cover Plates: Seat inside flanges and flush with finished floor. Provide cover plates for both power and communication services. Communication covers accommodate workstation connectivity outlets and modular inserts.
 - .4 Provide system manufacturer adapters, couplings, elbows, mud caps, marker caps, duct hold down straps, extension fittings, expansion joint sleeves and other installation and supporting hardware, required for complete installation as recommended by system manufacturer.
 - .5 Material Finishes: Selected from manufacturer standard enamel finishes and reviewed with Consultant.

2.02 TRENCH DUCT

- .1 General:
 - .1 CSA certified, and ULC listed and labeled.

- .2 Flush system consisting of distribution ducts, junction T and elbow assemblies, end closures, termination facilities, supports and required hardware.
 - .3 System to comply with industry standard Category rating for wiring run requirements of installed telecommunication cabling system. Coordinate requirements in accordance with Division 27.
 - .4 Submit detailed drawings with shop drawing submission. Drawings to show layout of raceways, shape, dimensions, and details for installation. Engage manufacturer representative to prepare submission drawings. Prior to manufacturing, submit samples of proposed duct, junction box, and accessories to Consultant.
 - .5 Duct system to have a controlled bend radius at every turning point to maintain integrity of communication cable installations.
- .2 Features:
- .1 Designed for large capacity requirements of single or multiple service systems. Refer to drawings for size and barrier requirements.
 - .2 Flush floor covers: 6.4 mm thick and relocatable to any location along trench.
 - .3 Covers accept finished floor tile as reviewed with Consultant and coordinated with General Trades Contractor.
 - .4 Gasketing for watertight functionality.
 - .5 No weld construction.
 - .6 Adjustable levelling feet.
 - .7 16 gauge galvanized steel body construction.
 - .8 Aluminum trim.
 - .9 Adjustable partitions.
 - .10 Support strips provide strength to support covers.
 - .11 Grommets attached to edges where cables egress duct.
 - .12 Various fittings and components to complete system requirements and UL scrub water tested.
- .3 Include required adapters, couplings, elbows and other installation and supporting hardware required for a complete installation as recommended by system manufacturer.

2.03 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Underfloor Duct System:
 - .1 Legrand (Wiremold).
- .2 Trench Duct:
 - .1 Legrand (Wiremold).
 - .2 ABB (T&B).
 - .3 Neidax Canadian Electrical Raceways.

3. Execution

3.01 INSTALLATION OF UNDERFLOOR DUCT SYSTEMS

- .1 Provide underfloor duct system with activations and wiring for power and communications. Prepare detailed installation drawings reviewed with Consultant and system manufacturer. Coordinate work with each trade.
- .2 Typical layout consists of single or multiple ducts feeding single or multiple distribution ducts. Drawings are diagrammatic and not used for exact measurements or exact routing. Layout raceways on specified centres, with duct sized as noted, complete with adjustable duct supports.
- .3 Obtain training from manufacturer representative on special installation procedures. Install duct system in accordance with manufacturer recommendations, installation instructions, and final installation drawings, suiting intended installation requirements. Coordinate installation with adjacent work, providing clearances for access and maintenance and to prevent electrical hazards. Use manufacturer recommended tools for cutting and installing duct. Remove burrs or sharp edges on material.
- .4 Provide concrete installation of concrete type recommended by system manufacturer and in accordance with requirements of Division 03. Do not use concrete containing chlorides over top of duct system. Design reinforced concrete in accordance with system manufacturer instructions.
- .5 Do not cover system work until inspected by Consultant and system manufacturer authorized representative. Seal gaps in system. Vibrate concrete at headers and raceways in accordance with manufacturer instruction so that concrete completely fills underneath duct system. Place and finish concrete at access openings such that cover plates are flush with top of concrete.
- .6 Place duct on supports and align presets, attach couplings and duct supports to duct. Secure joints with grounding screws or clips. Attach alignment clips to preset on each piece of duct. Adjust duct supports and duct distribution system so top of presets are below screed line in accordance with manufacturer instructions.
- .7 Permanently fasten duct supports to supporting framework. Spacing between supports to not exceed 1.5 m. Raceway supports include manufacturer recommended adjustments.
- .8 Install marker screw caps in place of standard preset mud caps in each preset, in adjacent to junction box, on each side of permanent wall, in final preset of each duct run, and on both sides of change in direction of duct.
- .9 Before concrete placement, make final inspection of entire duct system. Seal gaps in system with system manufacturer sealing compound to prevent mortar or concrete from entering system. Level junction box cover plates flush with finished concrete floor.
- .10 After placement of concrete fill, and before installing wiring, remove debris and other foreign materials from duct system. Install service fittings after installation of floor finishes. Cut floors as necessary, following duct manufacturer recommendations. Where moisture is present, remove cover plates from junction boxes to allow air circulation. Pull wire and cable from outlet insert toward junction boxes.
- .11 Mechanically continuously connect system to electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer installation sheets.
- .12 Do not use installed raceway system as working platforms or walkways.
- .13 Provide service fittings and equip with receptacle provisions.
- .14 Prior to ordering, review finishes of devices with Consultant.
- .15 Provide continuous paths along entire lengths of raceway to maintain proper ground continuity. Provide system manufacturer grounding fittings and hardware. Ground and bond system.

- .16 Close unused box openings using manufacturer recommended accessories.

3.02 INSTALLATION OF TRENCH DUCT SYSTEM

- .1 Provide a complete trench duct system with required accessories. Prepare detailed installation drawings reviewed with Consultant and system manufacturer and General Trades Contractor. Coordinate with each trade. Coordinate work with General Trades Contractor.
- .2 Obtain training from manufacturer representative on special installation procedures. Install duct system in accordance with manufacturer recommendations, installation instructions, and final installation drawings, suiting intended installation requirements. Use manufacturer recommended tools for cutting and installing duct. Remove burrs or sharp edges on material.
- .3 Coordinate installation work with general trades. Verify that floor slab is provided suiting in floor installation. Coordinate with trade responsible for pouring slab or cutting existing slab, as applicable. Verify that final finished assembly including finished floor tile is level with adjoining finished floor.
- .4 Before concrete placement, make final inspection of entire duct system. Seal gaps in system with system manufacturer sealing compound to prevent mortar or concrete from entering system.
- .5 Provide concrete installation of concrete type recommended by system manufacturer and in accordance with requirements of Division 03. Do not use concrete containing chlorides, over top of duct system. Design reinforced concrete in accordance with system manufacturer instructions. Place concrete in accordance with system manufacturer instructions and proper and accepted industry practice.
- .6 Do not cover system work until inspected by Consultant and system manufacturer authorized representative. Seal gaps in system. Vibrate concrete in accordance with manufacturer instruction so that concrete completely fills underneath duct system.
- .7 After placement of concrete fill, and before installing wiring, remove debris and other foreign materials from duct system.
- .8 Close unused openings using manufacturer recommended accessories.
- .9 Prior to ordering, review finishes with Consultant.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Testing and Verification:
 - .1 Arrange for manufacturer technician to perform onsite inspection, testing and certification of system prior to and after concrete pour.
 - .2 Inspect, start-up, test and verify products.
 - .3 Test each wiring device.
 - .4 Check connections and operations.
 - .5 Coordinate testing of wiring devices with requirements of Section 26 07 26 - Wiring Devices.
 - .6 Coordinate testing of telecommunication jacks and wiring with respective telecommunications and AV system vendors.
- .2 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 211.1-[06 (R2021)], Rigid Types EB1 and DB2/ES2 PVC Conduit.
 - .2 CSA C22.2 No. 2420-[09(R2023)], Below Ground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings (Bi-National Standard, with UL 2420).
 - .3 CSA Z809-[16(R2021)], Sustainable Forest Management.
- .2 Forest Stewardship Council (FSC):
 - .1 FSC-STD-01-001-[V5-3 ES 2015], FSC Principles and Criteria (P&C) for Forest Stewardship Standard.
- .3 Sustainable Forestry Initiative (SFI):
 - .1 SFI 2015-2019- [Extended through 2021], Standards and Rules.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports, and compliance certificates.

2. Products

2.01 DUCT FOR CONCRETE ENCASEMENT

- .1 DB/2 PVC:
 - .1 CSA certified.
 - .2 In accordance with CSA C22.2 No. 211.1.
 - .3 Non-metallic, PVC solid wall duct.
- .2 Rigid Fibreglass:
 - .1 CSA certified.
 - .2 In accordance with CSA C22.2 No. 2420.
 - .3 Non-metallic, fibreglass reinforced thermosetting resin conduit and fittings.
 - .4 Encapsulated in corrosion resistant epoxy resin system with UV inhibiting carbon black pigment.
 - .5 Suitable for installations in temperature range from minus 40°C to 110°C.

- .3 Conduit suitable for concrete encasement or direct burial installations and installed in accordance with requirements of AHJ.
- .4 Installed with synthetic polypropylene fibre (plastic) twine cord or 19 mm diameter polyethylene rope, and where required, approved by AHJ.

2.02 CABLE PROTECTION

- .1 Minimum 38 mm x 140 mm spruce-pine-fir pressure-treated type wood planks and with colour finish reviewed with Consultant. Provide treatment and finishes that do not injure conductors or conductor insulation.

2.03 MARKERS

- .1 Concrete Type Cable Markers:
 - .1 600 mm x 600 mm x 100 mm.
 - .2 Wording: "CABLE", "JOINT" or "CONDUIT" impressed in top surface.
 - .3 Arrows: Indicating change in direction of cable and duct runs.
- .2 Cedar Post Type Markers:
 - .1 In accordance with CSA Z809 or FSC-STD-01-001 or SFI 2015-2019 Standards and Rules.
 - .2 89 x 89 mm, 1.5 m long.
 - .3 Pressure treated and with colour finish reviewed with Consultant.
 - .4 Nameplates:
 - .1 Aluminum anodized, 89 x 125 mm, 1.5 mm thick.
 - .2 Mounted on cedar post with mylar label 0.125 mm thick.
 - .3 Wording: "CABLE", "JOINT" or "CONDUIT"
 - .4 Arrows to indicate change in direction.

2.04 WARNING TAPE

- .1 Standard 4 mil polyethylene 76 mm wide tape.
- .2 Yellow with black letters, imprinted with "CAUTION BURIED ELECTRIC CABLE BELOW".

3. Execution

3.01 DIRECT BURIAL OF CABLES

- .1 After laying sand bed in place, lay cables maintaining at least 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.
- .2 Direct bury cables as noted and as reviewed with Consultant.
- .3 Make cable terminations suiting cable and applications. Make splices only where reviewed with and as recommended by Consultant, and as noted. Leave at least 0.6 m of surplus cable in each direction. Make splices and terminations in accordance with manufacturer recommendations using manufacturer approved splicing kits.
- .4 Unless otherwise noted and recommended for acceptance by Consultant, do not make underground cable splices.

- .5 Minimum permitted radius at cable bends for rubber, plastic or lead-covered cables, is 8 times diameter of cable and in accordance with manufacturer recommendations. For metallic armoured cables, minimum permitted radius is 12 times diameter of cables and in accordance with manufacturer instructions.
- .6 Include offsets for thermal action and minor earth movements. Offset cables 150 mm minimum for each 60 m run, maintaining cable separation and bending radius in accordance with cable manufacturer requirements.
- .7 Cable Separation:
 - .1 Maintain at least 75 mm separation between cables of different circuits.
 - .2 Maintain at least 300 mm horizontal separation between low and high voltage cables.
 - .3 When low voltage cables cross high voltage cables, maintain at least 300 mm vertical separation with low voltage cables in upper position.
 - .4 At crossover, maintain at least 75 mm vertical separation between low voltage cables and at least 150 mm between high voltage cables.
 - .5 Maintain at least 300 mm lateral and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables in upper position.
 - .6 Install treated planks on lower cables at least 0.6 m in each direction at crossings.
- .8 After laying sand protective cover in place, install continuous row of overlapping pressure treated wood planks to cover length of run, unless otherwise noted.

3.02 CABLE INSTALLATION IN DUCTS

- .1 Install cables in ducts.
- .2 Do not pull spliced cables inside ducts.
- .3 Install multiple cables in duct simultaneously.
- .4 Use CSA certified 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 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.
- .8 For applications when installing cables in direct buried underground ducts, refer to Section 26 05 52 - Direct Buried Underground Cable Ducts.

3.03 INSTALLATION OF DUCT FOR CONCRETE ENCASED DUCTBANK

- .1 Provide ducts and concrete encasement in accordance details and with requirements of AHJ. Coordinate Work with trades responsible for performing excavation, backfill, and concrete Work.
- .2 Use standard duct lengths and fittings as much as possible and practicable. When cutting is necessary, taper duct ends with special field tapering machine. Make joints by means of standard couplings. Maintain minimum bending radius of 1 m.

- .3 Make concrete encased duct joints with use of couplings which provide a smooth watertight joint between ducts, using suitable cement that is specifically designed for use with duct pipe being used.
- .4 Separate ducts by means of plastic 75 mm spacers and placed 75 mm away from wooden forms on both sides ensuring that there is 75 mm of concrete between ducts and 75 mm concrete envelope around duct assembly. Refer to elevations and slopes of ducts as indicated or based on minimum 760 mm below finished grade and minimum 1% slope. Separate ducts with spacers at distance as required by AHJ and in accordance with duct manufacturer instructions. Do not locate spacers of vertical rows of ducts directly above each other. Maintain minimum 150 mm separation.
- .5 Where ducts cross roads, paved areas, disturbed ground, new or future, provide concrete envelope with 15 mm diameter reinforcing steel bars laid longitudinally along trench with 100 mm lateral spacing and 50 mm above base of concrete. Provide overlap of 600 mm on reinforcing bars, where necessary. Extend reinforcing 1.5 m beyond backfilled areas, driveways, roadways and other areas subject to vehicular traffic.
- .6 Reinforce duct runs at building entries for distance of 1.5 m out from such entry walls, bars being embedded in walls.
- .7 Do not place concrete around ducts, and do not backfill until duct line is inspected and reviewed with Consultant and AHJ. Where concrete is poured around ducts or where trenches are backfilled before ducts have been reviewed by Consultant and AHJ, remove and replace concrete allowing for approval inspections.
- .8 When conduit is laid and duct banks work completed and set, draw steel test mandrel through each duct, in presence of Consultant. Provide mandrel of diameter 13 mm less than inside diameter of duct. Remove obstruction found in duct and leave duct system completely clear. Before installation of feeders, allow Consultant to inspect and recommended as ready for feeder installation.
- .9 Whenever Work is suspended, protect ends of ducts by means of suitable plugs and leave such plugs in use as long as may be necessary. When conduit is installed for future extension, plug ducts and end of duct bank boxes for protection.
- .10 Do not lay defective ducts under any circumstances.
- .11 Concrete Used for Encasing Ducts: Minimum compressive strength of 20.7 mPa, unless otherwise noted in Division 03.
- .12 Compact and cover bottom of trench with freshly poured concrete bed minimum 75 mm thick, for full width of trench.
- .13 Lay lowest row of ducts on concrete bed, completely enclosed in concrete. Install subsequent layers in similar manner. Space ducts 150 mm centre to centre, both vertically and horizontally. Fill spaces between ducts with concrete.
- .14 Enclose ducts in minimum 75 mm thick envelope of concrete for full width of trench.
- .15 Fill entire space between ducts with concrete. Do not use concrete which has started to set to a point that it will not properly pour to smoothly fill spaces between and around ducts.
- .16 Use of monolithic method by placing ducts and pouring concrete around complete installation, is subject to approval from AHJ and review with and recommended by Consultant.
- .17 When placing concrete around ducts, maintain ducts in correct position with proper spacing and keep concrete from entering ducts.

- .18 Reinforce duct where duct crosses filled or disturbed ground.
- .19 Do not encircle a single conduit in a duct bank with metallic reinforcing rods or other conducting material. Entire duct bank may be encircled.
- .20 Maximum Size of Aggregate in Concrete: 10 mm.
- .21 Provide reinforcing rods and dowels in ductbank at building wall. Refer to detail.
- .22 Provide sloping and drainage of ducts, preventing pooling of water within ducts. Prior to start of Work, review requirements with Consultant.
- .23 Unless drainage provisions have been provided within building for duct draining, seal openings where ducts enter building, with elastomeric, fire rated, waterproof sealing material, preventing egress of water. Provide sealing material that can easily be removed for access to ducts.
- .24 Provide marking tape and marking pavers as required by AHJ.
- .25 Provide one continuous length of polyethylene rope in each duct indicated as spare or for future use.
- .26 Prior to covering, allow Consultant and AHJ to access and witness Work.
- .27 Refer to drawing details for additional requirements.

3.04 INSTALLATION OF MARKERS AND IDENTIFICATION TAPE

- .1 After laying sand protective cover in place:
 - .1 Install row of concrete cable markers covering length of runs. Lay concrete markers flat and centred over duct with top flush with finish grade.
 - .2 Apply identification tape on direct buried cable every 50 m along cable and underground duct runs.
 - .3 Mark changes in direction.
 - .4 Mark underground splices.
- .2 Install cedar post type markers where noted.
- .3 Where markers or tape are removed permitting installation of additional cables, reinstall markers or tape.

3.05 FIELD QUALITY CONTROL

- .1 Perform inspection, testing and verification work in accordance with Section 26 05 70 - Electrical Testing.
- .2 Before installation of cables and burying of ducts:
 - .1 Inspect ducts verifying free of foreign materials.
 - .2 Inspect connections and terminations, verifying installation in accordance with manufacturer instructions.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Check resistance to ground measurement 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 on each phase conductor.

- .2 Check insulation resistance after each splice and termination. Check that cable system is ready for acceptance testing.
- .6 Acceptance Tests:
 - .1 Perform testing of cables.
 - .2 Check that terminations and accessory equipment are disconnected.
 - .3 Ground shields, ground wires, metallic armour and conductors not under test.
- .7 Remove and replace entire length of cable where cable fails to meet test criteria.
- .8 Obtain compliance certificates for work. Include copies of certificates with reports.
- .9 Prepare testing and verification reports, signed by testing technicians. Include test results showing location at which each test was made, circuit tested and result of each test. Submit reports to Consultant.
- .10

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/Society of Cable Telecommunications Engineers (ANSI/SCTE):
 - .1 ANSI/SCTE 77-[2017], Specifications for Underground Enclosure Integrity.
- .2 ASTM International (ASTM):
 - .1 ASTM C857-[19], Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
- .3 CSA Group (CSA):
 - .1 CSA A23.1-[19], Concrete Materials and Methods of Concrete Construction.
 - .2 CSA A23.2-[19], Test Methods and Standard Practices for Concrete.
 - .3 CSA A23.4-[16(R2021)], Precast Concrete - Materials and Construction.
 - .4 CSA G40.20-[13]/G40.21-[13(R2018)] General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .5 CSA G164-[18], Hot Dip Galvanizing of Irregularly Shaped Articles.
- .4 Ontario Provincial Standard Specifications (OPSS):
 - .1 OPSS PROV 602, Construction Specification for Installation of Electrical Chambers [2017].

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit certificates from manufacturer certifying that maintenance vault materials comply with specified performance characteristics and physical properties.
- .4 Submit certified test reports for poured concrete from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties for intended applications to approval of AHJ.
- .5 Submit test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture meet specified requirements for intended applications to approval of AHJ.
- .6 Concrete pours: Submit accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken.
- .7 Submit compliance certificates, and testing and verification reports.

2. Products

2.01 TRANSFORMER PADS

- .1 Precast concrete transformer pad, accommodating electrical utility transformer and generally with following features:
 - .1 Consisting of precast concrete top cover and foundation.
 - .2 Sized in accordance with transformer requirements and electrical utility details.
 - .3 Concrete of minimum strength of 32 MPa, as confirmed with transformer manufacturer.
 - .4 Steel reinforced.
 - .5 Lifting holes.
 - .6 Top cover openings coordinated with final design of transformer as approved by electrical utility.
 - .7 Foundation cable openings coordinated with duct bank entry.
 - .8 Duct drainage suiting designed sloping of ducts.
 - .9 Drainage provisions consisting of sump pit, or duct opening in bottom for connection of drainage ducts, as noted, and as reviewed with Consultant.
- .2 Confirm and coordinate exact requirements with transformer requirements and electrical utility.

2.02 IN-GROUND HANDHOLES AND PULL BOXES

- .1 Construction Features:
 - .1 Fully weatherproof, watertight and corrosion-resistant types for splices, pulls and junction applications.
 - .2 Cast-in-place concrete.
 - .3 Precast concrete.
 - .4 Prefabricated made of semi-concrete or non-concrete materials polymer concrete.
- .2 In accordance with:
 - .1 ASTM C857.
 - .2 ANSI/SCTE 77.
 - .3 CSA certified.
 - .4 OPSS PROV 602.
 - .5 AHJ requirements.
- .3 Concrete:
 - .1 In accordance with CSA A23.1 and CSA A23.2.
 - .2 Minimum compressive strength: 32 MPa (4600 psi), 6-8% air entrainment.
 - .3 Suitable for installation and use through temperature range of minus 40°C to 70°C.
- .4 Polymer Concrete:
 - .1 Consists of aggregates in combination with polymer resin and reinforced with fibreglass.
 - .2 Non-conductive and non-flammable.
 - .3 Stable under freeze/thaw conditions.

- .5 Drainage Provisions: Consisting of sump pit or duct opening in bottom for connection to drainage ducts, as noted, and as reviewed with Consultant.
- .6 Enclosures:
 - .1 Designed and installed to withstand loads likely to be imposed.
 - .2 Size and of type suiting intended applications.
 - .3 With wiring/duct entries, covers and bottoms (as noted).
- .7 Steel Covers:
 - .1 Galvanized steel in accordance with CSA G40.20/G40.21 and CSA G164.
 - .2 Checker tread on top side for skid resistance.
 - .3 Tamper-proof, stainless steel head bolts recessed into cover.
 - .4 Area for logo.
 - .5 Flush mounted with gaskets preventing ingress of water.
 - .6 No protrusions extending out from top of cover; no tripping hazards.
 - .7 Minimum Thickness of Cover: 10 mm.
- .8 Cable Termination Hardware:
 - .1 Accommodates cables and required grounding hardware.
 - .2 Corrosion-resistant and in accordance with local governing code requirements.
- .9 PVC seals: On cable entry openings.
- .10 Identification:
 - .1 Identification engraving/warning signage, weather and corrosion-resistant.
 - .2 Identification markings on each box embedded on outside vertical surface of box, showing manufacturer name or trademark, and date of manufacture.
 - .3 Top surface of cover permanently marked, showing manufacturer name or trademark, and date of manufacture. Marking embedded into top surface of cover or embedded into corrosion-resistant metal plate securely cemented to top surface of cover.
- .11 Dimensions: As noted, and as reviewed with Consultant.

2.03 IN-GROUND MAINTENANCE VAULTS (MANHOLES)

- .1 General:
 - .1 In-ground maintenance vaults provided for concrete encased ductbank runs.
 - .2 With cast iron covers and collars/frames, ladders, cable pulling eyes, cable management trays, and ancillary devices.
 - .3 Sizing and locations: Suiting design requirements and applications.
 - .4 Work complying with electrical utility requirements, specifications, and details on drawings.
 - .5 In accordance with CSA A23.1 and CSA A23.4, and other applicable CSA Standards for intended applications.
- .2 Precast or cast in place concrete vaults to generally be as follows:
 - .1 Sized in accordance with detail.
 - .2 Concrete: Minimum strength of 32 MPa at 28 days (6-8%), suiting specific applications and code requirements.

- .3 Steel reinforced.
- .4 Cable openings coordinated with duct bank entry.
- .3 Provide accessories as follows:
 - .1 Minimum 800 mm diameter, minimum 10 mm thick, flush mounted cast iron cover with warning text on cover. Prior to ordering covers, review nomenclature with Consultant.
 - .2 No protrusions from top that may be tripping hazard.
 - .3 Covers with skid resistant surface and tamperproof corrosion-resistant cover bolts with suitable lifting provisions.
 - .4 Minimum 150 mm thick cast iron frame.
 - .5 Concrete levelling collars.
 - .6 Aluminum access ladders extending from access opening down to bottom of manhole.
 - .7 Galvanized steel cable pulling eye loops.
 - .8 Galvanized steel cable racks and trays.
 - .9 Structural lifting hooks on pre-cast units.
 - .10 Drainage: Storm sewer connection with cast iron service saddle with oil resistant gasket, stainless steel clamp and oil resistant O ring.
 - .11 Drainage Pits: 300 mm x 300 mm 125 mm, suitable for sump pump operation.
- .4 Coordinate exact drainage requirements with General Contractor and Mechanical Contractor (as applicable), suiting project design requirements and onsite provisions.

2.04 DUCT AND ACCESSORIES FOR CONCRETE ENCASEMENT

- .1 Refer to Section 26 05 52 – Direct Buried Underground Cable Ducts, for following products and requirements:
 - .1 PVC type DB/2 PVC duct and accessories.
 - .2 Fibreglass reinforced epoxy (FRE) conduit and accessories.
 - .3 Polypropylene pull cords.
- .2 Duct and accessories to be suitable for concrete encasement and in accordance with applicable AHJ and code requirements.

2.05 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Pre-cast Transformer Pads, Hand Holes, Pull Boxes and Maintenance Vaults:
 - .1 Brooklin Concrete.
 - .2 Industrial Cast Stone.
 - .3 Utility Structures.
 - .4 Hanson Pipe and Pre-cast.

3. Execution

3.01 INSTALLATION OF TRANSFORMER PAD

- .1 Provide transformer pad and foundation in location.

- .2 Coordinate responsibilities for provision of excavation, concrete, and backfilling work requirements.
- .3 Prepare ground, providing level and good draining foundation for pad and transformer. Coordinate cable entry opening with location of duct bank.
- .4 Perform installation in accordance with electrical utility requirements and with generally accepted trade practices.
- .5 Provide duct drainage.
- .6 Provide guard posts.
- .7 Provide grounding and bonding work.
- .8 Perform work under general supervision of General Contractor.

3.02 INSTALLATION OF IN-GROUND HANDHOLES AND PULL BOXES

- .1 Coordinate installation work with trades responsible for excavation and backfilling work.
- .2 Install handholes and junction boxes plumb, true to alignment and grade, and firmly bedded on drainage pocket backfill.
- .3 During installation, orient duct entry holes in required direction. Enlarging of duct entry holes is prohibited.
- .4 Coordinate connection of ducts, ensuring that proper sloping is maintained, suiting designed elevations and slope of duct run and required drainage.
- .5 Refer to drawing detail for additional requirements.
- .6 Provide grounding and bonding.
- .7 Confirm drainage provisions and provide. Coordinate work with General Contractor to connect drains.
- .8 Prior to backfilling and covering, obtain compliance certificates of work from electrical utility and review with Consultant.
- .9 Coordinate responsibilities for provision of excavation, concrete, and backfilling work requirements.

3.03 INSTALLATION OF IN-GROUND MAINTENANCE VAULTS

- .1 Provide maintenance vaults and associated work.
- .2 Coordinate responsibilities for provision of excavation, concrete, and backfilling work requirements.
- .3 Prepare ground, providing level and good draining foundation for vaults. Coordinate cable entry opening with location of duct bank.
- .4 Perform installation in accordance with electrical utility requirements and with generally accepted trade practices.
- .5 Provide grade levelling collars and neck such that cover is flush with finished grade in paved areas and 38 mm above grade in unpaved areas. Provide extension collars as required. Confirm final grade level with General Contractor.
- .6 Confirm drainage provisions and provide. Coordinate work with General Contractor to connect drains.

- .7 Coordinate connection of ducts and duct bank, ensuring that proper sloping is maintained, suiting designed elevations and slope of duct bank and required drainage.
- .8 Provide grounding and bonding.
- .9 Perform work under general supervision of General Contractor.
- .10 Prior to backfilling and covering, obtain approvals of work from electrical utility and review with Consultant.

3.04 INSTALLATION OF DECORATIVE CONCRETE BASES

- .1 Provide specified bases.
- .2 Install decorative concrete bases in accordance with manufacturer instructions and recommendations.
- .3 Coordinate responsibilities for provision of excavation, concrete, and backfilling work requirements.
- .4 Prepare ground, accommodating concrete pour. Coordinate cable entry opening with location of duct entries.
- .5 Refer to drawings for details and grade level. Confirm final grade level with General Contractor.
- .6 Coordinate connection of ducts, ensuring that proper sloping is maintained, suiting designed elevations and slope of duct.
- .7 Obtain anchor bolt template from pole manufacturer and set bolts aligned with poles.
- .8 Perform work under general supervision of General Contractor.
- .9 Prior to back filling and covering, review work with Consultant.

3.05 INSTALLATION OF DUCT FOR CONCRETE ENCASED DUCTBANK

- .1 Provide ducts and concrete encasement as noted, in accordance with requirements of AHJ and applicable codes and standards. Coordinate Work with trades responsible for performing excavation, backfill, and concrete Work. Confirm requirements with AHJ.
- .2 Coordinate work with Division 03 and Structural Consultant, as applicable.
- .3 Do not place concrete during rain or weather events that could damage concrete.
- .4 Use standard duct lengths and fittings as much as possible and practicable. When cutting is necessary, carefully taper duct ends with special field tapering machine. Make joints by means of standard couplings. Maintain minimum bending radius of 1 m.
- .5 Make concrete encased duct joints with use of couplings which provide a smooth watertight joint between ducts, using suitable cement that is specifically designed for use with duct pipe being used.

- .6 Separate ducts by means of plastic 75 mm spacers and placed 75 mm away from wooden forms on both sides ensuring that there is 75 mm of concrete between ducts and 75 mm concrete envelope around duct assembly. Provide elevations and slopes of ducts as noted or based on minimum 760 mm below finished grade and minimum 1% slope. Separate ducts with spacers at distance as required by AHJ and duct manufacturer instructions. Do not locate spacers of vertical rows of ducts directly above each other. Maintain minimum 150 mm separation. Where ducts crossroads, paved areas, disturbed ground, new or future, concrete envelope to have 15 mm diameter reinforcing steel bars laid longitudinally along trench with 100 mm lateral spacing and 50 mm above base of concrete. Provide overlap of 600 mm on reinforcing bars, where necessary. Extend reinforcing 1.5 m beyond backfilled areas, driveways, roadways and similar applications. Reinforce duct runs at building entries for distance of 1.5 m out from entry walls, with bars embedded in walls.
- .7 Do not place concrete around ducts, and do not backfill until duct line is inspected and reviewed for acceptance with Consultant and AHJ. If concrete is poured around ducts or if trenches are backfilled before ducts have been reviewed, be responsible for removing and replacing concrete at no extra cost to allow for approval inspections.
- .8 When duct has been laid and duct banks work completed and set, draw steel test mandrel through each duct in presence of Consultant. Diameter of mandrel to be 13 mm less than inside diameter of duct. Remove obstruction found in duct and leave duct system completely clear. No conduit will be accepted as being ready for installation of feeders until this is done.
- .9 Whenever Work is suspended, protect ends of ducts by means of suitable plugs and leave such plugs in use as long as may be necessary. When conduit is installed for future extension, plug ducts and end of duct bank boxes for protection.
- .10 Do not lay defective ducts under any circumstances.
- .11 Perform following requirements:
 - .1 Concrete used for encasing ducts to have minimum compressive strength of 20.7 mPa and in accordance with CSA A23.1 and CSA A23.2.
 - .2 Compact and cover bottom of trench with freshly poured concrete bed minimum 75 mm thick, for full width of trench.
 - .3 Lay lowest row of ducts on concrete bed, completely enclosed in concrete. Install subsequent layers in similar manner. Space ducts 150 mm centre to centre both vertically and horizontally. Fill spaces between ducts with concrete.
 - .4 Enclose ducts in minimum 75 mm thick envelope of concrete for full width of trench.
 - .5 Fill entire space between ducts with concrete. Do not use concrete which has started to set to a point that it will not properly pour to smoothly fill spaces between and around ducts.
 - .6 Use of monolithic method (i.e. placing all ducts and pouring concrete around complete installation) is subject to approval of AHJ and review with Consultant.
 - .7 Exercise with care when placing concrete around ducts to ensure that ducts remain in correct position with proper spacing and that no concrete enters any of ducts.
 - .8 Reinforce duct where duct crosses filled or disturbed ground.
 - .9 There must be no metallic reinforcing rods or other conducting material encircling a single conduit in a duct bank (entire duct bank may be encircled).
 - .10 Maximum size of aggregate in concrete to be 10 mm.

- .11 Provide reinforcing rods and dowels in ductbank at building wall as detailed.
- .12 Provide sloping and drainage of ducts to prevent pooling of water within ducts; review requirements with Consultant prior to start of Work.
- .13 Unless drainage provisions have been provided within building for duct draining, seal openings where ducts enter building with elastomeric, fire-rated, waterproof sealing material to prevent egress of water and that can easily be removed for access to ducts.
- .14 Provide marking tape and marking pavers as required by AHJ.
- .15 Provide one continuous length of polyethylene rope in each duct noted as spare or for future use.
- .12 Allow Consultant and AHJ (as applicable) access and opportunity to witness Work, prior to covering.
- .13 Refer to requirements of drawing details.

3.06 FIELD QUALITY CONTROL

- .1 Inspection, Testing and Verification:
 - .1 Inspect, test and verify products. Allow Consultant and AHJ to perform onsite inspection and testing.
 - .2 Testing of Cast-in-place Concrete Onsite:
 - .1 In accordance with Section 03 30 00 - Cast-in-Place Concrete.
 - .2 Test:
 - .1 Concrete pours.
 - .2 Slump.
 - .3 Air content.
 - .4 Compressive strength at 7 and 56 days.
 - .5 Air and concrete temperature.
 - .3 Check connections and operations.
- .2 Obtain compliance certificates for work. Include copies of certificates with reports.
- .3 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA A14-[07(R2022)], Concrete Poles.
 - .2 CSA A23.3-[24], Design of Concrete Structures.
 - .3 CAN/CSA-O15-[15(R2019)], Wood Utility Poles and Reinforcing Stubs.
 - .4 CAN/CSA-O80 Series-[21], Wood Preservation.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section. Include:
 - .1 Documentation that poles are suitable for steady wind velocity and gust velocity of area of installation.
 - .2 Documentation that poles are suitable for total effective projected area of mounted equipment.
 - .3 Detail of pole construction, dimensions, finishes, mounting and bases where applicable.
 - .4 In-ground detail identifying depth, as applicable.
 - .5 Where applicable, ice loads and seismic restraint considerations.
 - .2 Delegated Design:
 - .1 Submit detailed drawings of poles and bases, stamped and signed by Structural Professional Engineer experienced in pole design, including requirements of listed in above submittals.
 - .3 Include details and specifications from AHJ, as applicable.
- .3 Submit compliance certificates, and testing and verification reports.

2. Products

2.01 HIGH VOLTAGE CONCRETE POLES

- .1 General:
 - .1 Outdoor high voltage pole supports and provides connection to governing electrical utility incoming service.
 - .2 In accordance with electrical code and requirements of electrical utility.
 - .3 Spun concrete construction, with switches, pole line hardware, insulators, cross arm mounting, and other components in accordance with detail.
 - .4 Additional ancillary devices, suiting intended applications.

- .5 Service ratings as noted.
- .6 Components rated for service level and suitable for outdoor weatherproof applications.
- .2 Pole Features:
 - .1 Grey, tapered, round spun concrete, in accordance with CSA A14 and CSA A23.3.
 - .2 Minimum Class L, unless otherwise confirmed by pole manufacturer meeting requirements of intended application, and requirements of AHJ.
 - .3 Direct burial design.
 - .4 Resistance to insects, fire, rot and corrosion.
 - .5 Hollow raceway for internal wiring and components.
 - .6 Factory made raceways, hand holes, wiring apertures and bolt holes.
 - .7 Ladder clips or provisions for securing of future ladder.
 - .8 Grounding and bonding hardware, wiring, and continuous grounding bar.
 - .9 Ground conductors, copper clad ground rods, screw anchors, bronze connectors, and grounding of poles as detailed, and as required by electrical utility and codes.
 - .10 Limited 10 years warranty.
- .3 Fused Interrupters:
 - .1 Load break switches with cluster mounted fuses and surge arrestors, suiting intended service rating.
 - .2 Exact type and rating of switches and fuses, suiting intended applications in accordance with switch manufacturer recommendations and requirements of electrical utility.
 - .3 Configuration: Suiting intended applications and switch manufacturer recommendations and requirements of electrical utility.
 - .4 3-pole side break style with operating mechanism consisting of switch operating handle, vertical operating pipe, rod guides, couplings, insulators and key interlock
 - .5 Include for required ancillary devices as recommended by switch manufacturer.
 - .6 Include additionally for quantity of 3 spare high voltage fuses.
- .4 Pole line Hardware:
 - .1 Heavy duty, hot dipped galvanized and manufactured in accordance with CSA Standards for pole line hardware.
 - .2 Cross arms with required insulators, pins, washers, bolts and braces.
 - .3 Clamps, grips, clevis, bolt eyes, and ancillary mounting devices.
 - .4 Guy wiring, for required support: Wound stranded galvanized steel or aluminum wiring complete with anchors and hardware and protective safety covering.
- .5 Where underground conductors run in conduit up poles, provide hot dipped galvanized steel flared cover and suitable weather head at top end to prevent penetration of water into duct system.

2.02 WOODEN POLES

- .1 In accordance with CAN/CSA-O15 and CAN/CSA-O80 Series.
- .2 Minimum Class 3, western red cedar, unless otherwise noted.

- .3 Suitable for steady wind velocity and gust velocity of Place of Work, and suitable for total effective projected area of mounted equipment.
- .4 Increase Class where required by AHJ, or requirements of CAN/CSA-O15.
- .5 Preserved with environmentally friendly treatment in compliance with specific to application CAN/CSA-O80 Series and requirements of AHJ.
- .6 Unless otherwise required by AHJ, butt treat pole no less than to length that brings treatment to 300 mm above ground line.
- .7 Height and diameter: As notes, and complying with requirements of AHJ.
- .8 With equipment, hardware, insulators and associated components, suiting service voltage ratings of intended application.
- .9 With grounding and bonding requirements including ground rods.
- .10 Where underground conductors run in duct up pole, provided with suitable weather head at top end of duct to prevent water from entering duct system.
- .11 With identification marking located 3 m from butt of pole, identifying:
 - .1 Class and length.
 - .2 Species.
 - .3 Manufacturer identification.
 - .4 Year in which pole was treated.

2.03 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Concrete Poles:
 - .1 StressCrete.
 - .2 Utility Structures.

3. Execution

3.01 INSTALLATION OF POLES

- .1 Engage Delegated Design Professional Structural Engineer to review and endorse final pole design.
- .2 Poles for high voltage services: Installations and terminations performed by service contractors specializing in and licenced for providing this type of work.
- .3 Verify installation locations have sufficient clearance around and over pole locations.
- .4 Coordinate responsibilities for provision of excavation, and backfilling work requirements. Coordinate with General Contractor and trades responsible for excavation and backfilling work. Arrange for utility locates as required.
- .5 Excavate to proper depths, disturbing minimum amount of earth around poles. Set poles plumb and true in manner approved by AHJ and reviewed with Consultant. Tamp and compress soil by means of mechanical tampers.
- .6 Comply with pole manufacturer instructions with regards to pole installation and preparation of ground and sub-surfaces, accommodating pole installation. Provide required safety barriers.
- .7 Provide hoisting of pole.

- .8 Provide components and accessories. Provide guy wiring where necessary for additional support.
- .9 Coordinate connection of ducts.
- .10 Provide grounding and bonding.
- .11 Coordinate installation with electrical utility with regards to final pole location, height, cable terminations, and approvals of Work.
- .12 Perform work under general supervision of General Contractor.

3.02 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing and Verification:
 - .1 Arrange with Delegated Design Professional Engineer to review work of this Section and submit written reports verifying compliance with Contract Documents.
 - .2 Switch Manufacturer Authorized Technician: Provide onsite inspection, testing, adjusting, start-up, and verification of high voltage switches and components.
 - .3 Inspect, start-up, test and verify products.
 - .4 Check connections and operations.
- .2 Prepare testing and verification reports, signed by testing technicians and Delegated Design Professional Engineer. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 211.1-[06(R2021)], Rigid Types EB1 and DB2/ES2 PVC Conduit.
 - .2 CSA C22.2 No. 2420-[09(R2023)], Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings (Bi-National Standard, with UL 2420).

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions, and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit compliance certificates, and testing and verification reports.

2. Products

2.01 PVC DUCTS

- .1 Rigid type DB2/ES2, with fittings.
- .2 Suitable for direct burial.
- .3 CSA certified and tested in accordance with CSA C22.2 No. 211.1.

2.02 PVC DUCT FITTINGS

- .1 CSA certified, rigid PVC, opaque solvent welded type.
- .2 90° and 45° bends, and 5° angle couplings.
- .3 Couplings, bell end fittings, plugs, caps, adaptors and expansion joints.

2.03 SOLVENT WELD COMPOUND

- .1 Solvent cement for respective type of duct joints.
- .2 In accordance with duct manufacturer recommendations.

2.04 PULL CORDS

- .1 6 mm or greater diameter stranded polypropylene.
- .2 Tensile strength at least 5 kN, continuous throughout each duct run.
- .3 3 m length of spare rope at each end.

2.05 MARKERS

- .1 Concrete Type Markers:
 - .1 600 x 600 x 100 mm.
 - .2 Wording: "CABLE", "JOINT" or "DUCT" suiting intended applications and impressed in top surface.
 - .3 Arrows indicating change in direction of duct runs.
- .2 Cedar Post Type Markers
 - .1 Pressure treated with environmentally safe chromated copper arsenate finish, as reviewed with Consultant.
 - .2 Unless otherwise noted, 89 x 89 mm square, 1.5 m long.
 - .3 Nameplates
 - .1 Aluminum anodized.
 - .2 89 x 125 mm, 1.5 mm thick mounted on cedar post with mylar label 0.125 mm thick with wording: "CABLE", "JOINT", "CONDUIT".
 - .3 Arrows indicating change in direction.

2.06 WARNING TAPES

- .1 Standard 4-mil polyethylene 76 mm wide tapes.
- .2 Yellow with black letters, imprinted with "CAUTION BURIED ELECTRIC CABLE BELOW".

3. Execution

3.01 INSTALLATION

- .1 Perform excavation, trenching and backfilling work in accordance with requirements in Division 31.
- .2 Install and connect ducts in accordance with manufacturer instructions. Coordinate with trades responsible for performing excavation and backfill work. Refer to drawings for additional requirements.
- .3 Install rigid PVC DB2/ES2 duct for:
 - .1 Underground outside building under concrete, asphalt, and similar paving material and not subject to vehicular traffic.
 - .2 Designated runs as noted.
- .4 Install flexible plastic polyethylene pipe in continuous lengths wherever possible and "snake" conduit in trench. Make joints with mechanical couplings suiting intended applications. Use of heat fusion processes is subject to review with and recommendation for acceptance by Consultant. Terminate with rigid conduit threadless connectors.
- .5 Support underground duct on well-tamped flat bed of earth, free from rocks or protrusions. Grade and slope bed to provide ducts with proper drainage. Slope ducts with 1 to 400 minimum slopes, unless otherwise noted. Install with means carrying away drainage water.
- .6 Install duct at elevations as noted and reviewed with Consultant.
- .7 Clean inside of ducts before laying. Clean joints and apply sufficient solvent, making joints secure and watertight.

- .8 Install plastic duct spacers and verify even support every 1.5 m and smooth transition throughout duct length.
- .9 Provide manufactured expansion joints in rigid duct at spacing as recommended by duct manufacturer. Make joints waterproof and sealed tight.
- .10 Install plugs and cap both ends of ducts preventing entrance of foreign materials during and after construction. When duct is installed for future extension, plug end of duct for protection.
- .11 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, removing sand, earth and other foreign material.
- .12 Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .13 Install pull rope continuous throughout each duct run with additional length of 3 m rope at each end.
- .14 Provide separate ground conductor in non-metallic type duct runs, and in runs as noted.

3.02 INSTALLATION OF MARKERS AND WARNING TAPES

- .1 Install markers and warning tapes. Prior to ordering, review identification requirements and nomenclature with Consultant.
- .2 Before Backfilling:
 - .1 Install row of concrete cable markers covering length of duct runs. Lay concrete markers flat and centred over duct with top flush with finish grade.
 - .2 Apply continuous length of identification tape along underground duct runs
 - .3 Mark changes in direction.
 - .4 Mark underground splices.
- .3 Where markers or tapes are removed permitting installation of additional cables, reinstall markers or tapes.

3.03 FIELD QUALITY CONTROL

- .1 Notify Consultant for field review upon completion of direct buried ducts and obtain Consultant recommendation for acceptance prior to backfill.
- .2 Before installation of cables and burying of ducts:
- .3 Inspect ducts verifying free of foreign materials.
- .4 Test and inspect connections and terminations, verifying installation in accordance with manufacturer instructions.
- .5 Obtain compliance certificates for work and include with reports.
- .6 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.1-[24], Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit sample board of each type of proposed nameplates and signage.
- .4 Submit testing and verification reports.

2. Products

2.01 IDENTIFICATION – GENERAL

- .1 Non-climate-controlled areas: Nameplates and signage of weather-resistant and corrosion-resistant materials and UV-resistant preventing fading. Mounting hardware of corrosion-resistant stainless steel construction.
- .2 Nomenclature, print type and size, nameplate sizing, and colours: Prior to ordering, submit for review and recommendation for acceptance by Consultant.
- .3 Provide identification nameplates, labeling, operating instructions and signage.
- .4 Use one nameplate, or one label or one sign as noted, for each system, and for each piece of equipment.

2.02 MANUFACTURER EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened by manufacturer with stainless steel self-tapping mounting screws to each piece of equipment.
- .2 Lettering and numbers raised or recessed.
- .3 Information: As appropriate for respective application and type of equipment:
 - .1 Equipment: Manufacturer name, model, size, serial number, capacity.
 - .2 Electrical Ratings:
 - .1 Voltage, frequency, phase, power factor.
 - .2 Motor duty and frame size as applicable.
 - .3 Rated continuous current (main bus).
 - .4 Rated short-circuit withstand current.

- .3 Date of manufacture.
- .4 Instruction manual number.

2.03 SIGNAGE

- .1 Warning Signs:
 - .1 Porcelain enamel signs, minimum size 175 mm x 250 mm, and larger as sized on drawings or unless otherwise required by AHJ.
- .2 General Information Signage and Operating Instruction Signage
 - .1 Semi-rigid vinyl panels with drilled holes in each corner.
 - .2 Stainless steel self-tapping mounting screws.
 - .3 Pressure sensitive mounting pads on back.
 - .4 Nomenclature:
 - .1 Unless otherwise noted, red on white background with black trim.
 - .2 Prior to ordering, review with Consultant.
 - .5 Unless otherwise noted, minimum 3.2 mm thickness.

2.04 ASSET TAGS

- .1 Metal Types:
 - .1 Anodized aluminum.
 - .2 Print embedded within aluminum preventing fading or scuffing.
 - .3 Graphics, barcodes and numbers sealed into anodic layer of aluminum.
 - .4 For flat surfaces.
 - .5 Equivalent to 3M high bonding, permanent adhesive backing.
- .2 Plastic Types:
 - .1 Subsurface print on plastic.
 - .2 Graphics protected against abrasion / solvents.
 - .3 Weather and chemical proof.
 - .4 Conformable for any curved or flat surface.
 - .5 High bonding, permanent adhesive backing.
- .3 Size: Minimum 19 mm x 38 mm, unless otherwise noted.
- .4 Engraved with graphics, assigned number or barcode as confirmed with Owner and reviewed with Consultant.

2.05 PRODUCT IDENTIFICATION

- .1 Identify products (equipment) with nameplates as noted.
- .2 Nameplates:
 - .1 Lamicoid, minimum 3 mm thick, 2-ply, laminated coloured plastic plates.
 - .2 Bevelled edges and engraved lettering.
- .3 Nameplate sizes as follows:

Nameplate Sizes			
Size 1	10 x 50 mm	1 line	3 mm high letters

Nameplate Sizes			
Size 2	12 x 75 mm	1 line	5 mm high letters
Size 3	12 x 75 mm	2 lines	3 mm high letters
Size 4	20 x 100 mm	1 line	8 mm high letters
Size 5	20 x 100 mm	2 lines	5 mm high letters
Size 6	20 x 200 mm	1 line	8 mm high letters
Size 7	25 x 125 mm	1 line	12 mm high letters
Size 8	25 x 125 mm	2 lines	8 mm high letters
Size 9	35 x 200 mm	1 line	20 mm high letters

- .4 Use maximum 25 letters for each nameplate and each label.
- .5 Typical colours for nameplates (unless otherwise noted):
 - .1 Hazardous: Red letters, white background.
 - .2 Breakers on emergency power: Red letters, white background.
 - .3 Elsewhere: Black letters, white background (unless otherwise required by AHJ).
- .6 Typically, lettering of colour contrasting with lettering background.
- .7 Unless otherwise noted, identify equipment with nameplate no smaller than size 3.
- .8 Nameplates for motors, motor control centre, motor starters, motor starter or disconnect switch located in motor control centre or on motor starter panel, and on each individually mounted starter: Coordinate with Mechanical Division Work and indicate system, electrical ratings and equipment identification number.
- .9 Nameplates for terminal cabinets and junction boxes: Indicate system and voltage characteristics.
- .10 Interrupter switches, breakers, disconnects, starters and contactors: Indicate equipment being controlled, system and voltage.
- .11 Terminal cabinets and pull boxes: Indicate system and voltage.
- .12 Transformers: Indicate capacity, primary and secondary voltages.
- .13 Nameplates to completely identify equipment and its use with no abbreviations.
- .14 Wording is generally as noted and includes equipment service and building area/zone served.
- .15 Provide stainless steel self-tapping screws for securing nameplates in place.
- .16 Nameplates for equipment suspended above floor level, or generally not within easy viewing from floor level: Increase in size making it easier to read from floor level.

2.06 **WIRING IDENTIFICATION**

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour Coding: In accordance with CSA C22.1 and provincial electrical code.
- .4 Use colour coded wires in communication cables, matched throughout system.

- .5 Prior to start of Work, review final identification scheme with Consultant.

2.07 CONDUIT, BOXES AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and cables. For boxes, identify cover and inside each box.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 10 m (or less) intervals. Where tape is used, apply minimum of 2 wraps.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.
- .4 Colour Coding: Identify as described below:

	Prime	Auxiliary
up to 250 V Normal Power	Yellow	Blue
up to 600 V Normal Power	Yellow	Green
up to 250 V Emergency Power	Yellow	Blue and Red
up to 600 V Emergency Power	Yellow	Green and Red
Up to 250 V UPS Power	Yellow	Red
Up to 600 V UPS Power	Yellow	Yellow
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	----
Information Technology / LAN	Green	Green
Trunking Radio	Red	Yellow Yellow (2 bands)
Multi Media	Blue	Blue
Other Communication Systems (WAP, Cellular)	Green	Yellow
Fire Alarm	Red	----
Emergency Voice	Red	Blue
Security Systems	Red	Yellow
Clock Systems	Green	Blue
PA Systems	Green	White
CATV	Green	Red
Controls	Blue	----

- .5 Prior to start of Work, review final identification scheme with Consultant.

3. Execution

3.01 INSTALLATION OF SIGNAGE

- .1 Provide signage as noted.

- .2 Provide warning signage as specified and in accordance with requirements of AHJ.
- .3 Verify signage is visible and conform to applicable AHJ requirements.
- .4 Provide warning signs as applicable for following:
 - .1 On doors into transformer vaults.
 - .2 On doors into high voltage switchgear rooms.
 - .3 On doors to genset room.
 - .4 On doors into main electrical rooms.
 - .5 For other applications as noted.
- .5 Review nomenclature, sizing, colours and print type with Consultant. Provide number of signs as noted and supplemented as required by AHJ. Obtain AHJ approval, where required.
- .6 Secure signage with mechanical stainless-steel screws.
- .7 Above requirements are for typical pricing only. Prior to ordering, review final print type and size, colours and nomenclature with Consultant, and where required, AHJ. Obtain approvals, where required.
- .8 Submit sample of signage. Obtain Consultant recommendations for acceptance prior to ordering of products.
- .9 Refer to requirements within respective Sections for additional signage requirements.

3.02 INSTALLATION OF IDENTIFICATION PRODUCTS

- .1 Provide identification of products.
- .2 Verify manufacturer nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.
- .3 For asset tags, identification nameplates and signage, review nomenclature, sizing, colours and print type with Consultant. Provide number of signs as noted and supplemented as required by AHJ. Obtain AHJ approval, where required.
- .4 Secure nameplates with mechanical stainless-steel screws.
- .5 For each piece of electrical distribution equipment from electrical source of supply up to and including panelboards, for special control panels and cabinets, and for each other piece of electrical equipment, provide engraved lamicoid identification nameplates secured to apparatus with stainless steel screws. Provide nameplates indicating source of electrical supply and include Consultant equipment identification number. Identify whether equipment is on "NORMAL POWER SYSTEM" or "ESSENTIAL/EMERGENCY POWER SYSTEM", as applicable.
- .6 Equip large multiple cell or component apparatus such as switchgear, switchboards and distribution panels with main nameplates identifying equipment, voltage characteristics, capacity and source of supply, and with sub-nameplates clearly identifying each cell or component and its service.
- .7 For panelboard nameplates, inscribe with panelboard number as noted. Nameplates for disconnect switches, control panels and cabinets, outline their service and source of supply.
- .8 In areas where equipment having removable doors that are commonly installed on different equipment, identify each door to which piece of equipment it is associated with, such that nameplates are with correct equipment.

- .9 In pull boxes, junction boxes and at terminations, identify cable conductors with provision of plastic plates indicating system voltage and circuit designations. Provide 25 mm diameter plate with letter stamped 9 mm high and with colour coding in accordance with CSA C22.1, typically as follows:
 - .1 Phase A – red.
 - .2 Phase B – black.
 - .3 Phase C – blue.
 - .4 Neutral – white.
 - .5 Ground - green.
- .10 Above identification nameplate and nomenclature requirements are for typical requirements for pricing only. Prior to ordering, review final print type and size, colours, sizing and nomenclature with Consultant, and where required, AHJ. Obtain approvals, where required.
- .11 Submit sample board of nameplates. Obtain Consultant recommendations for acceptance prior to ordering of products.
- .12 Refer to requirements within respective Sections for additional identification requirements.

3.03 FIELD QUALITY CONTROL

- .1 Inspect and verify signs and identification labels and nameplates for correct:
 - .1 Construction materials.
 - .2 Size.
 - .3 Print type and print size.
 - .4 Nomenclature.
 - .5 Colours.
 - .6 Symbols.
 - .7 Attachments.
- .2 Prepare verification report signed by technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/American Society of Heating, Refrigeration and Air-Conditioning Engineers/Illuminating Engineers Society (ANSI/ASHRAE/IES):
 - .1 ANSI/ASHRAE/IES Standard 90.1-[2022] (SI Edition), Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group (CSA):
 - .1 CSA C22.1-[24], Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.
- .3 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE 80-[2013], IEEE Guide for Safety in AC Substation Grounding (Incorporates IEEE Std P80-2013/Cor 1-2015).
 - .2 IEEE 81-[2012], IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
 - .3 IEEE 142-[2007], IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - .4 IEEE 400.1-[2018], IEEE Guide for Field Testing of Laminated Dielectric, Shielded AC Power Cable Systems Rated 5 kV to 500 kV Using High Voltage Direct Current (HVDC).
 - .5 IEEE 400.2-[2013], IEEE Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF) (less than 1 Hz).
 - .6 IEEE 525-[2016], IEEE Guide for the Design and Installation of Cable Systems in Substations.
 - .7 IEEE 644-[2019], IEEE Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines.
 - .8 IEEE 1308-[2023] IEEE Recommended Practice for Instrumentation: Specifications for Magnetic Flux Density and Electric Field Strength Meters – 10 Hz to 3 kHz.
- .4 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S1001-[2023], Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.02 SUBMITTALS

- .1 At project start-up, review form of submittals with Consultant.
- .2 Where noted, submit reports and drawings stamped and signed by Professional Engineer.
- .3 Submit:
 - .1 System and equipment factory testing reports as noted in respective product sections.
 - .2 Product manufacturer standard procedures for systems and equipment inspection, testing, start-up, adjustments and verification.
 - .3 Certification of testing equipment proof of calibration.

- .4 Copies of certificate of pre-approvals from AHJ, as noted in respective product sections.
- .4 Submit After Installation and Testing:
 - .1 Completed testing and verification reports with completed test results sheets.
 - .2 Load balance reports.
 - .3 Compliance certificates from AHJ and manufacturers of systems and equipment, and as noted.

1.03 ACCEPTABLE TESTING COMPANIES

- .1 Proposed manufacturers of electrical distribution equipment on Project cannot be testing companies. Testing companies to be independent of equipment manufacturers/suppliers.
- .2 Electrical Testing Companies:
 - .1 Brosz Technical Services.
 - .2 Eastenghouse.
 - .3 G.T. Woods.
 - .4 Eaton Electric Services Division.
 - .5 Schneider Electric Services Division.
 - .6 Siemens Electric Services Division.
- .3 EMI Testing Companies:
 - .1 C-Intech.
 - .2 Power Line Systems Engineering.

2. Products (Not Used)

3. Execution

3.01 GENERAL

- .1 Prepare testing and verification reports based on performing inspection, testing and verification work including:
 - .1 Coordination with product manufacturers, performing manufacturer standard procedures for systems and equipment inspection, testing, start-up, adjustments and verification.
 - .2 Use of calibrated testing equipment and submission of proof of calibration of equipment within 30 days of start of testing Work.
 - .3 Performing testing, verification and commissioning of systems and equipment in accordance with issued commissioning sections.
 - .4 Presence onsite of electricians/trades people to:
 - .1 Handle equipment, make temporary connections, operate equipment and make repairs and adjustments.
 - .2 Assist testing and verification personnel during on-site inspection, testing, calibration, start-up, verification work and supplementary commissioning.
 - .5 Coordination of work.

- .2 General Product Testing Pass Criteria: Products considered as "Pass" meet each of following conditions unless otherwise noted:
 - .1 Inspected and tested in accordance with manufacturer guidelines and results conform with product performance specifications.
 - .2 Inspected and tested in accordance with Specifications and results conform with specified requirements.
 - .3 Inspected and tested in accordance with AHJ and results conforming with AHJ requirements.
- .3 Prepare testing reports and documentation for submission to Consultant. Include date and time of testing, testing technician name and signature.
- .4 Perform work under presence of Consultant and Commissioning Agent, at times reviewed with, recommended for acceptance by and scheduled with Consultant.

3.02 INSPECTION, START-UP, TESTING AND VERIFICATION REPORTS

- .1 Prepare and submit reports including:
 - .1 System/product model and components installed.
 - .2 Testing and commissioning record with checklist and test results and data for each of items specified.
 - .3 Make, model of testing instrument used.
 - .4 Findings.
 - .5 Deficiencies.
 - .6 Recommendations on remedial work.
 - .7 Date and time of testing.
 - .8 Statement that testing was successful, and Work complies with project documents, applicable standards, and requirements of AHJ.
 - .9 Signature of authorized testing technician, and sign-off by system manufacturer representative and Consultant review.
 - .10 Where noted, reports stamped and signed by Professional Engineer.
 - .11 Bound printed and electronic copies. Prior to start of Work, review number of copies and submission requirements with Consultant.

3.03 INSPECTION, TESTING, START-UP AND VERIFICATION WORK

- .1 When each system and each major piece of equipment (such as switchgear, switchboards, transformers, panelboards, gensets, ATS, UPS, fire alarm system) installation is complete and ready for acceptance, perform onsite system inspection, testing, start-up, and verification. Where noted, arrange for system and equipment manufacturer authorized representative to perform this Work. Use final reviewed and accepted reports from Section 26 05 73 - Power System Studies. Perform following general procedures applicable to product:
 - .1 Check component connections and overall installation.
 - .2 Adjust sound systems for high quality, distortion-free performance, free from noise, cross-talk, hum or other interference.
 - .3 Test products and ascertain that products are as specified in respective product Sections and verify that products operate as designed by manufacturer.

- .4 Adjust systems and ascertain that system components are as specified in respective product sections and verify that system components operate as designed by manufacturer, in accordance with sequence of operations as noted for respective systems.
- .5 Perform start-up procedures for systems and equipment, in accordance with respective product manufacturer instructions.
- .6 Certify component operations.
- .7 Prepare, document and evaluate test results.
- .8 Authenticate test results with signature of authorized testing technician.
- .9 Check and verify nameplates.
- .10 Prepare and submit maintenance and operating instructions.
- .2 Perform work properly documented and in accordance with manufacturer instructions and recommendations.
- .3 Integrated Systems Testing Of Fire Protection And Life Safety Systems:
 - .1 Engage Integrated Testing Coordinator to prepare and execute Integrated Testing Plan, oversee integrated testing onsite and provide requirements in accordance with CAN/ULC-S1001 and AHJ.
 - .2 Prepare and coordinate Integrated Testing Plan prior to start of verification work.
 - .3 Include for but not be limited to full review, testing and verification of operation of integrated systems such as fire suppression systems, life safety systems, elevators and their emergency sequence of operation, HVAC equipment, supervisory annunciation of sprinkler/standpipe monitor switches, pressure switches and flow switches, diesel genset alarms, security alarms, BAS alarms, release of door holders and electromagnetic locks, and other integrated components.
 - .4 Coordinate requirements with trades responsible for integrated components and systems and arrange trades to be present at time of testing, and verification and commissioning work.
 - .5 Test and verify performance of each integrated piece of equipment and system as integral parts combined into functional system.
 - .6 Modifications to Existing Systems: Test and verify performance of each modified integrated piece of existing equipment and existing systems as integral parts combined into functional system. Existing equipment and systems not modified can be noted as not in scope of Work.
 - .7 Arrange and make available parties including Integrated Testing Coordinator, witnesses and AHJ, as required for witnessing of testing.
 - .8 Document testing and results in report, signed by testing technician, and listing Integrated Testing Coordinator, witnesses and AHJ.
- .4 Rectify deficient work, and work that failed testing and re-test and re-verify, until successful testing.
- .5 Document testing and results in report, signed by testing technician and listing witnesses.

3.04 ELECTRICAL TESTING AND VERIFICATION

- .1 Include for 3rd party testing company to perform specified electrical distribution system inspection, testing and verification work. Testing company is independent of equipment manufacturers and employs Professional Engineer to sign and seal testing and verification reports.

- .2 Prior to system and equipment being energized, conduct electrical distribution system inspection, testing and verification work. Perform further testing when energized. Include following items, as applicable to product requirements:
 - .1 Testing, cleaning when necessary, and calibrating and setting relays and circuit breaker trip devices. Calibrate and set protective devices in accordance with results of coordination curves reviewed and recommended for acceptance by Consultant, as specified in Section 26 05 73 - Power System Studies.
 - .2 Function test of associated control devices.
 - .3 Replacement of fuses destroyed during testing.
 - .4 Acceptance test in presence of Consultant and Commissioning Agent.
 - .5 Presence, for length of time required, of equipment manufacturer service technician during start-up.
 - .6 Perform insulation resistance testing of outgoing feeders with respect to ground. Before energizing system, check resistance to ground.
 - .7 Inspection and Testing:
 - .1 Power generation and electrical distribution system including phasing, voltage, grounding and load balancing.
 - .2 Cables, bus duct, power panels, lighting panels, transformers, power receptacles and switches.
 - .3 Electrical system auxiliary systems and devices such as metering, power factor capacitors, UPS, transfer switches, inverters, central battery systems, engine generator sets and load banks.
 - .4 Electrical devices and communication system components installed as noted and including in service consoles, furniture systems, and mill work.
 - .5 Motors, motor control equipment, starters and variable frequency drives.
 - .6 Heat tracing, snow melting, heaters and associated control equipment including sequenced operation of systems.
 - .7 Lighting and lighting control systems including central control systems, low voltage relays, sensors and dimming controls. Verification that devices perform in accordance with ANSI/ASHRAE/IES Standard 90.1 requirements.
 - .8 Lightning protection systems.
 - .8 Verification and certification work of equipment and systems including fire alarm system, security systems and communication systems. Refer to product testing requirements in respective Sections of Divisions.
 - .9 Witness testing of EMI testing and verification of test results.
- .3 Perform general electrical tests as follows:
 - .1 After luminaires, switches, receptacles, motors, signals, and other equipment, are installed, test work to verify that there are no grounds or crosses.
 - .2 Establish and verify proper motor rotation. Measure full load running currents and check overload elements. Report to Consultant, discrepancies which are found. Check motors which have been worked on (disconnected and reconnected), with rotation meter verifying proper rotation.
 - .3 Test circuits originating from branch distribution panels and verify with documented test results that branch circuit voltage drop is within specified limits.
 - .4 Load Balance:

- .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections to obtain best balance of current between phases and record changes.
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Upon completion of work, prepare and submit load balance report. Identify phase and neutral currents on panelboards, dry-core transformers and motor control equipment, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .5 Verify that devices are commissioned and operable.
- .4 **Electrical Receptacle Testing:**
 - .1 Visually inspect each receptacle for physical integrity.
 - .2 Verify continuity of grounding circuit in each electrical receptacle.
 - .3 Check for correct polarity of hot and neutral connections in each receptacle.
 - .4 Test retention force of grounding blade of each receptacle except locking-type receptacles. Confirm retention force is not less than 115 g.
 - .5 Include in test reports documentation showing every receptacle tested, details of what test were conducted on that receptacle, and whether they passed or failed retention tests.
- .5 Perform and document equipment service procedures in accordance with manufacturer instructions and recommendations. Provide instruments, meters, equipment and personnel to conduct tests during and substantial completion of project.
- .6 Where relays, breakers, and other overcurrent protective devices do not perform to Consultant reviewed coordination study curves as prepared and as specified in Section 26 05 73 - Power System Studies, revise devices as part of work.
- .7 Adjust and calibrate existing equipment trip units, relays, breakers and other overcurrent protective devices, which do not perform to reviewed and approved coordination curves. Where defective or incorrectly applied devices are found in existing distribution system, identify problem areas clearly on curves of test report and provide recommended course of remedial action. Identify on coordination curves in report and identify recommended remedial course of action.
- .8 **Low Voltage Cable Testing:**
 - .1 Perform on cables specifically directed within Specification sections.
 - .2 Perform after cable installation, and before termination to any equipment or accessories.
 - .3 Perform insulation resistance (megger) test to detect conductor insulation damage that may have been caused during installation. This type of test is Pass/Fail testing or dielectric withstand test.
 - .4 Perform testing in accordance with cable manufacturer recommended procedures.
 - .5 Determine minimum acceptable insulation resistant values using IEEE 525 as standard of acceptance.
- .9 **High Voltage Cable Testing:**
 - .1 Perform after cable installation, and before termination to any equipment or accessories.

- .2 Perform testing in accordance with cable manufacturer recommended procedures.
- .3 From following 2 testing methods paragraphs, select testing procedure. DC hi-pot testing is no longer preferred method but review for acceptance. Edit as required.
- .4 Very Low Frequency (VLF) Testing:
 - .1 Test high voltage cable installation using very low frequency method in accordance with IEEE 400.2.
 - .2 Apply AC sinusoidal waveform, at 0.01 to 0.1 Hz, to assess quality of insulation of cables.
 - .3 Subject cables to test voltage significantly higher than what they experience during normal operating condition, in accordance with IEEE 400.2 and as recommended by cable manufacturer.
 - .4 Refer to IEEE 400.2 for recommended acceptance levels.
- .5 DC Hi-Pot Testing:
 - .1 DC hi-pot test high voltage cable installation in accordance with IEEE 400.1.
 - .2 Perform phase verification, grounding verification, hi-pot test of insulation strength to IPCEA Specifications (obtain Leakage Curves), and time domain reflectometer tests to give records of cable impedance profiles to draw attention to cable damage.
 - .3 Reference IEEE 400.1 and cable manufacturer testing procedures and do not exceed maximum test voltage levels and durations.
 - .4 Refer to IEEE 400.1 for recommended acceptance levels.
 - .5 Where not recommended by cable manufacturer, do not perform DC hi-pot testing. Perform very low frequency method in accordance with IEEE 400.2.
- .10 Unless otherwise noted, do not perform hi-pot testing (meggering) of cabling or other equipment with SPDs connected.
- .11 Report cable defects to Consultant as soon as such defects are discovered, and rectify defects. After repair, re-test affected cables. Also, re-test cables where cable damage is suspected following installation. On completion of testing of installation with passing results, submit report stating that cables concerned passed required tests and are suitable for service. Submit reports to Consultant. Submit recorded test data with report, in each case.
- .12 Before placing in regular service, test main power transformers. Perform voltage ratio test, phase angle test, insulation resistance, oil sampling (liquid type transformer), start-up and other manufacturer recommended tests.
- .13 Verify and coordinate testing of power factor levels and testing of power factor correction equipment, with manufacturer of equipment. Refer to Section 26 35 33 - Power Factor Correction.
- .14 Provide visual and mechanical inspection of ground system and verify compliance with issued documents and electrical code requirements.

- .15 Perform fall-of-potential test in accordance with IEEE 81 on main grounding electrode/plate system, determining current status, possible grounding contamination and proper ground resistance value. Perform point-to-point tests, determining resistance between main grounding system and major electrical equipment frames system neutral, or derived neutral points. (Major equipment: Such as switchgear, switchboards, gensets, power transformers). Resistance between main grounding electrode and ground is not typically greater than 5 ohms, in accordance with IEEE 142.
- .16 Coordinate testing of equipment and systems with respective product vendors, verifying conformance with product vendor standards.
- .17 Rectify deficient work, and work that failed testing and re-test and re-verify, until successful testing.
- .18 Document results into testing and verification report signed by Professional Engineer. Report states that testing was successful and Work complies with project documents, applicable CSA standards and AHJ requirements. Witnesses also to sign-off reports.

3.05 INFRARED SCANNING

- .1 Perform infrared scanning of work and connections to electrical distribution equipment including following:
 - .1 Switchgear and switchboards.
 - .2 Transformers.
 - .3 Panelboards.
 - .4 Busducts.
 - .5 Power generators.
 - .6 UPS units.
 - .7 Power conditioners.
 - .8 Motor control equipment and starters.
- .2 Use infrared fast scanning thermal imaging camera with colour digital conversion thermographic imaging capabilities. Equipment detects emitted radiation and converts detected radiation to visual image. Use camera to determine temperature differences using generated isotherms.
- .3 Perform scanning of distribution system, with ability to detect 1 C° between subject area and reference at 30°C.
- .4 Perform infrared surveys during periods when equipment is under intended full operating load.
- .5 Perform scanning of essential power equipment when gensets are in operation and essential power is on-line.
- .6 Guidelines for interpretation of temperature gradients (above normal operating temperatures):
 - .1 Temperature gradients of 3 C° to 7 C° indicate possible deficiency and warrant investigation.
 - .2 Temperature gradients of 7 C° to 15 C° indicate deficiency and require repair as time permits. Review with Consultant.
 - .3 Temperature gradients of 16 C° and above indicate major deficiency and require repair immediately. Review with Consultant.

- .7 Rectify deficient work and work that exceeded stated temperature difference criteria, and repeat scanning until temperature difference meets criteria.
- .8 Document testing in report stamped and signed by Professional Engineer, that includes:
 - .1 Indication of problem area (location of "hot spot").
 - .2 Indication of temperature rise between "hot spot" and normal or reference area.
 - .3 Indication of cause of heat rise.
 - .4 Indication of phase unbalance.
 - .5 Indication of areas scanned.
 - .6 Colour photographs and thermograms of deficient area as seen on imaging system.
 - .7 Summary of work.
 - .8 List of test equipment.
 - .9 Faults, corrections required and recommendations.
 - .10 Retesting of corrected faults.
- .9 Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI):
 - .1 ANSI Z535.3-[2022], Criteria for Safety Symbols.
 - .2 ANSI Z535.4-[2023], Product Safety Signs and Labels.
 - .3 ANSI Z535.6-[2023], Product Safety Information in Product Manuals, Instructions and Other Collateral Materials.
- .2 CSA Group (CSA):
 - .1 CSA Z462-[24], Workplace Electrical Safety.
- .3 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE 1584-[2018], IEEE Guide for Performing Arc-Flash Hazard Calculations.

1.02 SUBMITTALS

- .1 Submit reports and drawings stamped and signed by Professional Engineer.
- .2 Submit power system studies consisting of:
 - .1 Electrical distribution system protective device coordination study and short circuit calculations. (preliminary and final).
 - .2 Electrical testing reports.
 - .3 Arc flash analysis report.
- .3 Submit sample of arc flash label with sample lettering.
- .4 Submit preliminary electrical distribution system coordination study and short circuit calculations reports prior to or with proposed shop drawings of major electrical distribution equipment such as switchgear, switchboards, main power transformers, gensets, transfer switches). Allow sufficient time in shop drawing process, for Consultant to review and make comments and for equipment vendors to incorporate Consultant comments, revisions, and results of reports into equipment shop drawings. Order equipment after shop drawings have been reviewed with and recommended for acceptance by Consultant.
- .5 Time for this shop drawing review process is at Consultant discretion, but typically allow for 15 working days for initial review submission with additional 10 working days added to accommodate each resubmission.
- .6 Where formal completion of studies and reports cause delay in equipment manufacture and consequently in construction schedule, obtain direction from Consultant for preliminary submittal of sufficient data allowing for selection of device ratings and characteristics meeting proposed equipment manufacturer recommendations on short circuit current ratings at available fault currents of electrical distribution system.
- .7 Subsequently, provide complete and final studies and reports to verify preliminary findings.
- .8 At project start-up, review form of submittals (submission procedures, number of hard copies and requirements for electronic copies) with Consultant.

1.03 ACCEPTABLE POWER SYSTEM STUDIES COMPANIES

- .1 Utilize proposed manufacturers of electrical distribution equipment on Project to prepare power system studies.
- .2 Power System Studies Companies:
 - .1 Brosz Technical Services.
 - .2 Eastenghouse.
 - .3 G.T. Woods.
 - .4 Eaton Electric Services Division.
 - .5 Schneider Electric Services Division.
 - .6 Siemens Electric Services Division.

2. Products (Not Used)

3. Execution

3.01 GENERAL SCOPE OF WORK

- .1 Prepare and submit preliminary and final coordination study and short circuit calculations and recommendations on required relays, sensors and current transformers (CTs) for proper system selective coordination and protection.
- .2 Determine short-circuit current ratings, checking that electrical distribution equipment can safely withstand level of fault current.
- .3 Prepare studies to simulate distribution in all modes of operation (such as utility and emergency) and consider worst-case requirements when considering short circuit, coordination and incident energy.
- .4 Prepare, determine and submit arc flash hazard analysis study with calculations, qualifying required electric shock and arc flash protection provisions.
- .5 Use final reviewed and accepted reports in testing, start-up and verification work of Section 26 05 70 - Electrical Testing.
- .6 Check that Mechanical Division equipment includes required short-circuit current ratings.
- .7 Coordinate work with equipment and system manufacturer authorized technician in performing final testing, start-up and verification procedures to equipment and systems, as part of work of Section 26 05 70 - Electrical Testing.
- .8 Engage manufacturer of selected major electrical distribution equipment to prepare and submit power system studies consisting of coordination studies with short circuit calculations and arc flash hazard analysis.
- .9 Prepare testing and verification reports, documenting results, observations and recommendations, and signed by testing technician. Submit to Consultant. Where specified, submit reports stamped and signed by Professional Engineer.

3.02 PRELIMINARY COORDINATION STUDY AND SHORT CIRCUIT CALCULATIONS

- .1 Contact and coordinate with electrical supply authority to obtain information on relays and other protective devices installed on their system and substations which affect coordination of site electrical distribution system. Incorporate information into report with coordination study and short circuit calculations. Submit reports to electrical supply authority and AHJ for review where requested. Make revisions to reports as requested.

- .2 Contact and coordinate with proposed manufacturer of electrical distribution equipment, obtaining appropriate information and recommended devices for co-ordination of electrical distribution system. Incorporate information into coordination study and short circuit calculations.
- .3 Where project involves provision of major electrical distribution equipment (such as high voltage equipment, low voltage switchgear and switchboards, genset paralleling/synchronization switchboards), prepare preliminary coordination study and calculate available fault currents based on project design requirements and equipment. Combine into preliminary report and submit to Consultant. Incorporate Consultant comments into equipment shop drawings.
- .4 Prepare report to standards as specified in distribution system coordination study and short circuit calculation report article.

3.03 DISTRIBUTION SYSTEM COORDINATION STUDY AND SHORT CIRCUIT CALCULATIONS

- .1 Prepare power system studies including coordination study and short circuit calculations (available fault currents) of system. Perform work to requirements of AHJ and CSA Standards.
- .2 Review and survey existing systems and obtain where available, coordination study of existing systems to use in ensuring proper protective device coordination and suitable withstand rating for entire existing, additional and revised distribution equipment and systems. Where existing studies are not available, survey existing systems and prepare additional studies, providing full and proper coordination and suitable withstand rating of entire existing, revised and additional distribution equipment and systems.
- .3 Incorporate results and Consultant reviewed comments of final coordination study and short circuit calculations reports into electrical distribution equipment shop drawings to update and to reflect final supplied equipment. Check for selective coordination of devices and verify short circuit current withstand ratings of equipment meet results from reports. Prepare studies, providing full and proper coordination and suitable withstand rating of entire distribution equipment/systems.
- .4 Select protective system devices such that protection is adequate and good coordination is possible, however, differences exist between manufacturers. Make changes in trip ratings or relay settings, suiting requirements of supplied equipment. Obtain electrical utility information on their protective devices and include requirements.
- .5 Prepare and coordinate set of coordination curves on K.E. No. 336E Time Current Characteristic graph paper.
- .6 Include symmetrical and asymmetrical fault current calculation data with tabulations verifying protection of various elements of systems under maximum and minimum fault conditions at various points in systems.
- .7 Coordinate and provide plot time-current characteristic curves for:
 - .1 Main and feeder protective devices at voltage levels used in distribution system.
 - .2 Protective devices associated with:
 - .1 Motors greater than 75 HP and connected with VFDs.
 - .2 Refrigeration machine compressors.
 - .3 Largest device in each distribution panel.
 - .3 Motor generator protective devices, with damage curves and current decrement curves.

- .8 Cooperate with and obtain from other manufacturers, list of equipment requiring use of protective devices in distribution system and prepare coordination curves. Coordinate with manufacturers of equipment connected to distribution system, verifying that proper withstand ratings of equipment are provided and proper control and protective devices are selected such that they coordinate with protective devices.
- .9 Engage equipment manufacturers to examine plans and specifications, verifying that relays and protective devices being installed in distribution system provide coordination meeting requirements of coordination study.
- .10 Submit to transfer switch manufacturers, coordination results and available fault current values at locations of transfer switches. Coordinate that transfer switches are provided with short circuit current rating to withstand specific available fault current.
- .11 Prepare reports and drawings including:
 - .1 Results with plotted curves.
 - .2 Tabulated short circuit ratings at each piece of equipment.
 - .3 Tabulated coordination settings for adjustable trip units.
 - .4 Identified trouble areas of coordination.
 - .5 Extensive comments regarding results and recommendations on best course of remedial action.

3.04 SHOCK AND ARC FLASH ANALYSIS

- .1 Prepare analysis for electric shock and arc flash protection.
- .2 Prepare study determining severity of potential exposure and selecting personal protective equipment (PPE) in accordance with CSA Z462.
- .3 Determine arc flash hazard distance and incident energy that workers may be exposed to and from electrical equipment in accordance with IEEE 1584.
- .4 Design safety signs and labels for applications to equipment, in accordance with CSA Z462, ANSI Z535.3, ANSI Z535.4 and ANSI Z535.6.
- .5 Arc Flash Hazard Analysis Study:
 - .1 Perform Arc Flash Hazard analysis by calculating arc flash incident energy and arc flash boundaries in accordance with CSA Z462. Identify locations where work is performed on energized parts of equipment such as switchboards, switchgear, motor-control centres, panelboards, busway and splitters.
 - .2 Use short circuit calculations and clearing times of phase overcurrent devices from short circuit and coordination study specified previously.
 - .3 Arc flash hazard analysis to include equipment and systems from customer owned service entrance equipment down through equipment rated 208 volts with significant locations in 240 V and 208 V systems fed from transformers equal to or greater than 35 kVA.
 - .4 Specify safe working distances based upon calculated arc flash boundary considering incident energy of 1.2 cal/cm².
 - .5 Highlight in red, computation results identifying incident energy levels above certain levels (typically 40 cal/cm² unless otherwise noted by AHJ).

- .6 Include analysis calculations for maximum and minimum contributions of fault current magnitude. Minimum calculation assumes that utility contribution is at a minimum and a minimum motor load. Conversely, maximum calculation assumes a maximum contribution from utility and motors operating under full-load conditions. Include other switching scenarios as necessitated by power system design and layout.
- .7 Arc Flash computation includes both line and load side of main breaker, where necessary. Where Arc Flash reduction maintenance system is provided with breaker, include results in Arc Flash computation.
- .8 Base Arc Flash calculations on overcurrent protective device clearing time in accordance with coordination study.
- .6 Arc Flash Warning Labels:
 - .1 Provide minimum 90 mm x 127 mm thermal transfer type label of high adhesion polyester for each work location analysed.
 - .2 Unless otherwise noted, provide red header label with "DANGER, ARC FLASH HAZARD" wording. Provide orange header label with wording, "WARNING, ARC FLASH HAZARD", and include following information:
 - .1 Location/equipment designation.
 - .2 Nominal voltage.
 - .3 Arc flash protection boundary.
 - .4 Incident energy.
 - .5 Working distance.
 - .6 Engineering report number, revision number and issue date.
 - .3 Machine print labels with no field markings. Submit as shop drawing submissions, sample labels and proposed nomenclature.
 - .4 Provide Arc Flash labels for following equipment (and base labels on recommended overcurrent device settings):
 - .1 High voltage equipment.
 - .2 Switchgear.
 - .3 Switchboards.
 - .4 Transfer switches.
 - .5 Genset control equipment.
 - .6 Distribution transformers.
 - .7 Panelboards.
 - .8 Motor control equipment and VFDs.
 - .9 Other equipment as noted, and as required by AHJ.
- .7 Document in report, method of calculating and data to support information for labels. Incorporate documentation with power system studies report submitted to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA):
 - .1 ANSI/NEMA MG 1-[2021], Motors and Generators.
- .2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE):
 - .1 ANSI/ASHRAE/IES Standard 90.1-[2022] (SI Edition), Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3 CSA Group (CSA):
 - .1 CSA C22.2 No. 100-[14(R2024)], Motors and Generators.
 - .2 CSA C22.2 No. 145-[22], Electric motors and generators for use in hazardous (classified) locations (Tri-national standard, with NMX-J-652-ANCE and UL 674).
 - .3 CSA C390-[22] Test Methods, Marking Requirements, and Energy Efficiency Levels for Three-Phase Induction Motors.
 - .4 CSA C747-[22], Energy Efficiency Test Methods for Small Motors.
- .4 National Research Council (NRC):
 - .1 National Energy Code of Canada for Buildings (NECB), [2020]

1.02 SUBMITTALS

- .1 Submit schedule of motors listing following data:
 - .1 Equipment name and number.
 - .2 Motor size.
 - .3 Frame size.
 - .4 Electrical characteristics, including voltage, phase, full load amps, locked rotor amps and unique requirements.
 - .5 Motor design.
 - .6 Insulation class.
 - .7 Temperature rise in accordance with insulation class.
 - .8 Continuous service factor.
 - .9 Guaranteed minimum efficiency and power factor at 75% and 100% of full load.
 - .10 Enclosure type.
- .2 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Indicate dimensions, recommended installation procedure, wiring diagrams, sizes and location of mounting bolt holes and recommended support method.

- .3 Indicate:
 - .1 Overall dimensions of motor.
 - .2 Shaft centreline to base dimension.
 - .3 Shaft extension diameter and keyway, coupling dimensions and details.
 - .4 Fixing support dimensions.
 - .5 Dimensioned position of ventilation openings. Details of ventilation duct attachments.
 - .6 Terminal box location and size of terminals.
 - .7 Arrangement and dimensions of accessories.
 - .8 Diagram of connections.
 - .9 Starting current and relative data necessary for use in design of motor starting equipment.
 - .10 Speed/torque characteristic.
 - .11 Weight.
 - .12 Installation data.
- .4 Submit certification from motor manufacturer that air flow cooling motors used on AC variable speed drives is adequate down to 10% of nameplate rated speed.
- .5 Submit testing and verification reports.

2. Products

2.01 MATERIALS

- .1 Motors:
 - .1 In accordance with ANSI/NEMA MG 1.
 - .2 CSA certified and labeled.
 - .3 Non-hazardous Locations: In accordance with CSA C22.2 No. 100.
 - .4 Hazardous Locations: In accordance with CSA C22.2 No. 145.
 - .5 Vertically mounted and submersible motors purposely designed for mounting in altitude of place of Work.
 - .6 Motors for horizontal or vertical mounting as noted, with required mounting hardware and rails.
- .2 Efficiency:
 - .1 NEMA Premium efficiency.
 - .2 In accordance with ANSI/NEMA MG 1, ANSI/ASHRAE/IES Standard 90.1 and NECB.
 - .3 1-Phase Motors to 1 Horsepower (HP): Also, in accordance with CSA C747.
 - .4 3-Phase Motors 1 HP and Larger: Also, in accordance with CSA C390.
- .3 Provide motors on mechanical equipment as noted that meet or exceed efficiencies in accordance with NEMA MG-1 premium efficiency levels in Section II Part 12.60 Corrosion Prevention and Finish Painting.
- .4 Motors Installed in Non-Climate Protected Areas: Finishes resistant to corrosion from severe moisture conditions, and weather protected.

- .5 Motors for equipment which are specifically scheduled or specified with corrosion-resistant coating or constructed from corrosion-resistant materials: Additional factory coating with primer and epoxy paint finish.

2.02 FRACTIONAL HORSEPOWER MOTOR (UP TO 1 HP)

- .1 Rating: 115 V or 120 V as applicable, single phase, unless otherwise noted.
- .2 Standard Features:
 - .1 Continuous duty capacitor start type.
 - .2 Rigid cast iron or steel frame of NEMA 48 or 56 frame size, solid base, heavy-gauge steel shell with solid die-cast end shields.
 - .3 Dynamically balanced die-cast rotor.
 - .4 Integral automatic reset thermal overload protection.
 - .5 1.15 service factor at 40°C ambient temperature.
 - .6 Complete with Class "B" insulation, unless otherwise noted.
 - .7 Ambient operating temperatures: Minus 20°C to 40°C.
 - .8 IP 55 degree of protection, unless otherwise noted or suiting environmental conditions.

2.03 MOTORS (1 HP TO 200 HP)

- .1 Ratings: 208 V or 575 V or 600 V as applicable, 3 phase, as noted.
- .2 Standard Features:
 - .1 Totally enclosed fan cooled (TEFC), unless otherwise noted.
 - .2 Squirrel cage, continuous duty, drip proof, induction motors.
 - .3 NEMA Design "B" for normal starting torque or Design "C" for high starting torque suiting intended applications.
 - .4 Complete with Class "B" insulation, unless otherwise noted.
 - .5 1.15 service factor at 40°C ambient temperature.
 - .6 Maintenance-free permanently sealed and lubricated anti-friction bearings.
 - .7 Cast iron or steel T-frame, rigid and machined keeping parts in alignment under full load. With cast iron feet suiting intended applications.
 - .8 Cast iron or steel end bracket and precision machined bearing fit, and balanced carbon steel shaft assembly with die-cast aluminum rotor windings.
 - .9 Cast iron or steel, gasketed conduit boxes.
 - .10 Drain plugs located on end shields.
 - .11 Internal epoxy coating of interior of motor for moisture and corrosion resistance.
 - .12 Etched stainless steel manufacturer nameplates.
 - .13 Ambient operating temperatures: Minus 20°C to 40°C.
 - .14 IP 55 degree of protection, unless otherwise noted and suiting environmental conditions for applications.
- .3 Controller Compatibility: Compatibility as documented by motor manufacturer when connected to variable speed drives, variable frequency drives active front end drives or other types of controllers.

2.04 REQUIREMENTS FOR SPECIAL APPLICATIONS

- .1 Motors for 2-Speed Cooling Towers: As specified above but 2-speed single winding type.
- .2 Motors for 2-Speed Fans: As specified above but 2-speed double winding type.
- .3 Motors 30 HP and Larger: Include heat sensing positive temperature coefficient (PTC) thermistor in end turn of stator winding for each phase and connected in series inside motor with 2 marked leads brought out to motor conduit box.
- .4 Motors for Equipment with Variable Frequency Drives:
 - .1 As specified above but inverter duty type in accordance with ANSI/NEMA MG-1, quantified by CSA for operation from variable frequency drive of specified type.
 - .2 Class "H" insulation and insulated bearings.
 - .3 Shaft grounding ring system protecting bearings from damage by diverting harmful shaft voltages and bearing currents to ground.
- .5 Motors 150 HP and Larger: With "wye-delta" reduced voltage starters complete with six leads for connection to motor starter.
- .6 Motors in Non-climate Controlled Areas: Weather-protected and corrosion-resistant, providing proper operations in cold temperatures and protection from rain, dust and snow.
- .7 Explosion-Proof Motors Features:
 - .1 Totally enclosed, fan cooled, unless otherwise noted.
 - .2 In accordance with CSA C22.2 No. 145.
 - .3 Other similar above respective to type standard features, but additionally suitable for use in Class 1 Group D hazardous locations.
 - .4 1.0 service factor at 40°C ambient temperature.

2.05 COMPONENTS AND ACCESSORIES

- .1 Bearings:
 - .1 Type: Anti-friction deep groove ball or roller bearing, with grease lubrication fittings on frame 254T and larger.
 - .2 Life: Bearing life based on no external radial or axial load as follows:
 - .1 3600 r/min: 30,000 hours.
 - .2 1800 r/min and less: 60,000 hours.
- .2 Thermal Protection:
 - .1 Thermistor protection, one per phase, with tripping device on following motors:
 - .1 Motors used with variable frequency drives.
 - .2 Motors 50 HP and larger.
- .3 Belt Drives:
 - .1 Fit reinforced belts in sheave matched to drive. Provide multiple belts as matched sets.
 - .2 Provide cast iron or steel sheaves secured to shafts with removable keys, unless otherwise noted.
 - .3 For motors under 10 HP: Standard adjustable pitch drive sheaves, with plus or minus 10% range. Use mid-position of range for specified r/min.

- .4 For motors 10 HP and over: Sheave with split tapered bushing and keyway having fixed pitch unless otherwise noted for item concerned. Provide sheave of correct size suiting balancing.
- .5 Determine and select correct size of sheave during commissioning.
- .6 Minimum Drive Rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates provided for centre line adjustment.
- .4 Drive Guards:
 - .1 Provide guards for unprotected drives.
 - .2 Guards for Belt Drives:
 - .1 4-sided, fully enclosed, expanded galvanized metal screen welded to steel frame.
 - .2 Factory primed and painted with yellow equipment enamel.
 - .3 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .4 40 mm diameter holes on both shaft centres for insertion of tachometer.
 - .5 2-piece full length hinged front panel permitting belt maintenance or replacement without removing guard.
 - .3 Provide means for lubrication and use of test instruments with guards in place.
 - .4 Install belt guards allowing movement of motors for adjusting belt tension.
 - .5 Guards for Flexible Coupling:
 - .1 "U" shaped, minimum 2.3 mm thick galvanized mild steel frame and expanded mesh face.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.
 - .6 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 20 mm mesh.
 - .2 Net Free Area of Guard: Not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.
- .5 Shaft Extensions: Mild steel or stainless-steel construction, for accessories and applications such as keeping motor shaft out of fan air flow, suiting intended applications and equipment manufacturer requirements.
- .6 Brakes: For applications to stop and hold motor and its driven load, suiting intended applications and equipment manufacturer requirements.
- .7 Clutches: Electrically operated, suiting intended applications and equipment manufacturer requirements.
- .8 Space Heaters:
 - .1 For installations in non-climate controlled areas and of high humidity.
 - .2 Powered on when motor is off.
- .9 Accessories suitable for use in same hazardous location as that specified for motor.
- .10 Anchor devices and setting templates.

- .11 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and motor manufacturer recommendations.

2.06 ELECTRONICALLY COMMUTATED MOTORS (ECMS)

- .1 ECMs are DC motors that include electronic controls to vary motor speed and increase efficiencies.
- .2 Features:
 - .1 Ratings: Suiting intended applications and equipment manufacturer requirements.
 - .2 High efficiency.
 - .3 Variable speed.
 - .4 Brushless.
 - .5 Microprocessor based motor controller factory programmed specifically to operate connected equipment.
 - .6 Permanent magnet type motor rotor with near zero rotor losses.
 - .7 Built-in soft start and soft speed change ramps.
 - .8 Permanently lubricated with ball bearings.
 - .9 Thermal overload protection.
- .3 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and motor manufacturer recommendations.
- .4 Provide type of ECM suiting respective equipment, intended applications and equipment manufacturer requirements.

2.07 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Motors:
 - .1 Baldor (ABB).
 - .2 GE Industrial Motors.
 - .3 Leeson (Regal Beloit).
 - .4 Marathon (Regal Beloit).
 - .5 TECO-Westinghouse.
 - .6 Toshiba.
 - .7 U.S. Motors (Nidec).
 - .8 WEG Motors.

3. Execution

3.01 INSTALLATION

- .1 Refer to drawings and schedules of equipment and motor driven equipment. Identify differences between submitted schedule and Contract Document schedule. Provide motors as scheduled. Coordinate with Division 23 Mechanical Contractor.

- .2 Review and coordinate motor electrical characteristics and requirements between respective Divisions. Review voltage, phase, power ratings and motor compatibility with respective motor control centers and variable frequency drives.
- .3 Install motors in accordance with manufacturer instructions and electrical code.
- .4 Dry out motor where dampness is present.
- .5 Install motors on slide rails, baseplate, driven machinery, structure and concrete base, as indicated and as required suiting intended applications. Check that concrete bases have fully cured before installation, are rigid, plumb and square. Coordinate with requirements of Division 03. Hoist and locate using lifting facilities in accordance with manufacturer instructions.
- .6 Fasten securely in place.
- .7 Mount motors in locations for ease of removal, replacement, servicing and operating.
- .8 Allow adequate space for servicing motors and for removal of motors from motor-driven equipment.
- .9 Make wiring connections. Use liquid tight PVC jacketed flexible conduit between rigid conduit and motor, allowing for extra 180° loop of flexible conduit at connection point to isolate vibration.
- .10 Make wiring connections between variable frequency drives and motors. Provide cable for VFD application as specified in Section 26 05 19 - Low Voltage Electrical Power Conductors and Cables.
- .11 Make flexible conduit long enough, permitting movement of motor over entire length of slide rails.
- .12 Check for correct direction of rotation, with motor uncoupled from driven equipment.
- .13 Align and couple motor to driven machinery, using correct parts such as couplings, belts, sheaves, as provided by manufacturer.
- .14 Adjust axial and differential alignment of motor with driven equipment for vibration free operation.
- .15 Provide guards for exposed accessible rotating parts such as belt drives, couplings, fan wheels, and shaft ends on mechanical equipment. Such guards protect personnel from hazards including those created by point of operation, in-running nip points, rotating parts, flying chips and sparks.
- .16 Install belt guards allowing movement of motors for adjusting belt tension.
- .17 Secure guards to equipment or equipment base but do not bridge sound or vibration isolation.
- .18 Provide means permitting lubrication and use of test instruments with guards in place.
- .19 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 accessible location using aluminium or copper tubing.
- .20 Ground and bond motors and associated equipment.
- .21 Provide identification nameplates.
- .22 Where delivery of specified motor delays completion or commissioning work, install motor suitable for work, for temporary use. Work to only be accepted when specified motor is installed and successfully tested.

3.02 FIELD QUALITY CONTROL

- .1 Upon completion of installation, perform following:
 - .1 Inspection, start-up, testing and verification of each motor.
 - .2 Verify that respective motor type and rating matches mechanical equipment requirements.
 - .3 Adjust and preset motors in accordance with intended applications.
- .2 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 Canadian Council of Ministries of the Environment (CCME):
 - .1 PCB Transformer Decontamination: Standards and Protocols, [1995].
- .2 Government of Canada:
 - .1 Canadian Environmental Protection Act, [(1999) amended 2020].
 - .2 Hazardous Products Act, [(1985) amended 2018].
 - .3 Transportation of Dangerous Goods Act, [(1992) amended 2019].
 - .4 Reg. 278/05: Designated Substance -Asbestos on Construction Projects and in Buildings and Repair Operations
- .3 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE 644-[2019], IEEE Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit following as applicable to work:
 - .1 Identification of waste treatment facility proposed and description of type of waste that facility is licensed to handle.
 - .2 Certificate of PCB material treatment laboratory credentials.
 - .3 Waste tracking procedure.
 - .4 Testing reports with completed test results sheets.
 - .5 Compliance certificates or certificate of approvals.
 - .6 Description of closure plan of facility.
 - .7 Copies of insurance and bonding.
 - .8 Certificates of destruction.

2. Products

2.01 GENERAL

- .1 Products: As specified under Part 3 descriptions for providing respective Work.

2.02 ACCEPTABLE SERVICE COMPANIES

- .1 Hazardous Waste Removal Companies:
 - .1 Caliber Environmental Construction Services, Inc.

- .2 Envirosafe Inc.
- .3 Ferro Environmental.
- .4 I & I Construction Services.
- .5 JMX Environmental Inc.
- .2 Richmond Hill Environmental Consultants:
 - .1 ECOH Environmental.
 - .2 Safetech Enviornmental.
- .3 EMI Mitigation Companies:
 - .1 C-Intech.
 - .2 Power Line Systems Engineering.

3. Execution

3.01 HAZARDOUS MATERIALS

- .1 Hazardous materials and infectious materials are known to be present on site in existing buildings, including but not limited to following:
 - .1 Aspergillus.
 - .2 Mould.
 - .3 Asbestos.
 - .4 Polychlorinated biphenyls (PCBs).
 - .5 Lead.
 - .6 Mercury.
- .2 All Drywall Joint Compound (DJC) is asbestos containing and should be removed using appropriate Asbestos abatement procedures, in coordination with the Environmental consultant.
- .3 Include for company specializing in removal and disposal of materials containing polychlorinated biphenyls (PCBs) to disassemble equipment to access material containing PCBs and remove and properly dispose of such material off site.
- .4 Check luminaires being deleted for ballast containing PCBs. Disconnect and dispose off-site ballast containing PCBs. Only companies that are certified and comply with local governing Ministry of Environment and Ministry of Transport regulations with regards to hazardous waste materials to perform this Work. Prior to start of Work, submit to Consultant, copy of PCB disposal certificate and identification of Ministry authorized and designated disposal site. Remove and transport lamps containing mercury (fluorescent lamps) to government approved disposal site. Do not send ballasts containing PCBs to metal recycling.

3.02 PCB REMOVAL, TRANSPORTATION AND DISPOSAL

- .1 Engage specialty service company to perform polychlorinated biphenyls (PCBs) abatement removal work.
- .2 General Scope of Work:
 - .1 Coordination with Owner, submission of Generator Registration Report (GRR).

- .2 Completing and submitting to AHJ, Generator Registration Report (GRR) and making fee payments.
- .3 Perform removal work of existing equipment (transformers, capacitors and ballasts) and associated cables containing PCBs.
- .4 Perform PCBs abatement removal work.
- .5 Workers act in manner that is consistent with safe handling, loading, testing, and transporting PCB material.
- .6 Engage approved treatment facility to test PCB materials.
- .3 Company Qualifications:
 - .1 Experienced and certified in province of Place of Work.
 - .2 Approved by governing Ministry of Environment (MOE).
 - .3 Licensed by AHJ.
 - .4 A Member of the Environmental Abatement Council of Canada (EACC - <https://www.eaccanada.ca/>)
 - .5 Employ workers involved in handling, loading, transportation and destruction of PCB material that are trained and licensed in accordance with Workplace Hazardous Materials Information System (WHMIS) and Transportation of Dangerous Goods Act, Transport Canada (TDG).
- .4 Refer to Divisions 00 and 01 for liability insurance requirements:
- .5 Work performed in accordance with Federal and Provincial Regulations, Codes, Standards and Policies, including:
 - .1 Occupational Health and Safety Act.
 - .2 Transportation of Dangerous Goods Act.
 - .3 Canadian Environmental Protection Act, Environment Canada.
 - .4 For applications of PCB transformers: PCB Transformer Decontamination: Standards and Protocols.
 - .5 Workplace hazardous materials as outlined in Hazardous Materials Information System as established in Hazardous Products Act.
 - .6 Ministry of the Environment and Climate Change.
- .6 Work includes but is not limited to providing following:
 - .1 Administering, supervising, arranging, and coordinating of work.
 - .2 Obtaining permits and approvals and payment of fees associated with performing Work.
 - .3 Submission to Consultant:
 - .1 Detailed report of work.
 - .2 Copies of permits and certificate of approvals (compliance certificates).
 - .3 Documentation identifying site where equipment and materials are delivered. Identify proposed transporting route and means for moving materials from building and site. Submit these details as shop drawings.
 - .4 Disconnection and decommissioning of equipment containing PCBs.

- .5 Disconnection and making safe of connections (primary and secondary power cabling, controls and protection circuits, and monitoring circuits) to existing transformers. Replace connectors and wiring that have come into contact with PCBs.
- .6 Sampling and testing of liquids for PCBs.
- .7 Waste Oil Handling:
 - .1 Not containing PCBs less than amount in accordance with AHJ regulations: Send to recycling facility.
 - .2 Containing PCBs in amounts exceeding governing regulations: Send to approved facility for storage and destruction in accordance with governing regulations.
- .8 Draining of PCB containing liquid from equipment.
- .9 Dismantling and cutting-up of equipment, for PCB decontamination and removal from building and site.
- .10 Packaging of PCB containing and contaminated materials, for removal from building and site.
- .11 Removal from site of materials and transportation of PCB containing materials to AHJ approved designated facility.
- .12 Remove materials from site and properly dispose of in manner approved by AHJ.
- .13 Not storing any PCB containing materials onsite.
- .14 Perform work required for inspecting, characterizing packaging, labelling, loading, transportation, decontamination and/or destruction of PCB material.
- .15 Prior to start of Work, review with Consultant and obtain Consultant recommendations for acceptance of path of egress for removal of equipment and components. Protect egress from spills and other damage that may occur in movement of material.
- .16 Perform Work at scheduled times approved in writing by Owner and reviewed with Consultant.
- .17 Remove waste in expedient manner in accordance with agreed project schedule.
- .18 Engage approved facility to store, destruct, decontaminate and dispose PCB containing materials.
- .19 No later than 30 days after PCB waste is removed from site, submit copies of final Certificates of Destruction for All Waste (solid/liquid) to Consultant.
- .20 Obtain Certificate of Approvals as follows:
 - .1 Waste Management Systems.
 - .2 Transportation.
 - .3 Transfer.
 - .4 Treatment.
- .7 Inspections and Characterization:
 - .1 Provide materials and labour required for inspection of PCB materials prior to each shipment of PCB Material.
 - .2 Characterize and profile PCB material as required in accordance with requirements of TDG and WHMIS and other applicable federal, provincial, or municipal regulations.

- .3 Sample, characterize, and profile PCB material, including preparation of waste profile sheets (WPS) with WPS Numbers assigned specifically to each existing PCB filled power transformer. Utilize comprehensive computerized bar-coded waste tracking system by treatment facility, ensuring accurate tracking of PCB Material. Computerized bar-coding system minimizes risk of human error when moving waste. Consultant reserves right to inspect waste tracking procedures throughout duration of Work.
- .8 Treatment Facility:
 - .1 Canadian Association for Laboratory Accreditation (CALA) approved laboratory facility for analysis of various types of PCB Materials. Submit certificate of laboratory credentials and description of types of waste that treatment facility can receive, with shop drawings.
 - .2 Test PCB samples taken from materials before and after decontamination treatment.
 - .3 Submit copy of waste tracking procedure as part of shop drawings. This procedure includes tracking of PCB material sent to third party for incineration. This procedure explains how specific WPS used for this project is tracked throughout work.
 - .4 PCB Materials carry bar coding from point of pick-up of PCB Materials from site.
 - .5 Include with shop drawings:
 - .1 Copy of Certificate of Approval.
 - .2 Description of closure plan of facility, that includes closure bond, which can be used in event of insolvency or bankruptcy of service specialty company. Include amount of this bond sufficient to cover cost of destruction for materials which appear in Certificate of Approval for storage at service specialty company facility at any given time.

3.03 ELECTROMAGNETIC INTERFERENCE PROVISIONS

- .1 Electromagnetic interference (EMI) provisions include shielding of applicable structures, systems and components.
- .2 Engage specialty service company to provide work. Specialist company to have minimum 10 years experience in engineering design and installation on power frequency electromagnetic shielding, with past experience on projects with similar conditions.
- .3 Cover wall behind vertical bus duct risers with electromagnetic shielding, consisting of solid hot-rolled pickled steel or μ -metal (mu-metal). Design shielding, reducing magnetic field radiated from bus duct to maximum of 5 milligauss at distance of 500 mm from wall in adjacent offices and occupied spaces.
- .4 Enclose horizontal bus duct runs in ventilated shielding enclosures, reducing magnetic field radiation from bus duct to floors above and below and maintaining full bus duct ampacity. Provide shielding with sufficient attenuation ratio reducing magnetic field to 5 milligauss or less at desk top level 900 mm above floor.
- .5 Cover floor under main power transformers with continuous shielding slab of sufficient grade to reduce magnetic field radiation from transformers to 5 mG at desktop level on occupied floors below. Mount transformers on oil and chemical resistant nitrile rubber type isolators.
- .6 Prior to installation of electrical equipment and after civil work is finished, install wall and floor-mounted magnetic shields. After bus duct installation, install shielding enclosure on horizontal bus duct runs.

- .7 Test and verify shielding performance in accordance with IEEE 644.
- .8 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 APPLICATION

- .1 This Section specifies commissioning requirements that are common to electrical work Sections and Sections of Division 27 and Division 28 unless otherwise noted, and supplements to each Section.
- .2 This Section supplements requirements of Division 01.
- .3 Where requirements of this Section contradict requirements of Division 01, request for clarification from Consultant.

1.02 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - .1 ASHRAE Guideline 0-[2019], The Commissioning Process.
 - .2 ANSI/ASHRAE/IES Standard 90.1-[2022] (SI Edition), Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group (CSA):
 - .1 CSA C282-[19], Emergency Electrical Power Supply for Buildings - Including Maintenance Logbook.
 - .2 CSA Z320-[11(R2021)], Building Commissioning.
- .3 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S524-[Edition 7, 2019], Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S536-[Edition 5, 13-R2018], Inspection and Testing of Fire Alarm Systems.
 - .3 CAN/ULC-S537-[Edition 6, 2019-REV1], Verification of Fire Alarm Systems.
 - .4 CAN/ULC-S561-[Edition 3, 2020-REV1], Standard for Installation and Services for Fire Signal Receiving Centres and Systems.
 - .5 CAN/ULC-S1001-[2023], Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.03 DEFINITIONS

- .1 Commissioning: Process of demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, as further described below.
- .2 Commissioning Agent: Commissioning authority who supervises commissioning process and recommends final acceptance of commissioned electrical work.
- .3 Start-Up and Adjusting: Process of equipment manufacturer/supplier technical personnel, with respective Division Contractor, starting and operating equipment and systems, making adjustments, documenting process, and submitting manufacturer/supplier start-up reports confirming that equipment is properly installed and is operational as intended.

- .4 Pre-Functional Performance Testing: Testing, adjusting and operating of components, equipment, systems and subsystems, by respective Division Contractor, after start-up but before functional performance testing, confirming that components, equipment, systems and subsystems operate in accordance with requirements of Contract Documents, including modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets.
- .5 Functional Performance Testing: Repeat of successful pre-functional performance testing by respective Division Contractor, in presence of Commissioning Agent and Consultant with completed Commissioning Agent commissioning documentation sheets documenting, validating, and verifying that equipment, systems and subsystems are complete, function correctly, and are ready for acceptance.
- .6 Commissioning Documentation Sheets: Prepared sheets for pre-functional performance testing and for functional performance testing, supplied by Commissioning Agent for each piece of equipment and system commissioned. Each sheet or set of sheets are complete with Project name and number, date of commissioning, equipment or system involved, equipment or system name and model number, and equipment identification as identified on drawings. For each commissioning procedure listed, include on sheets, column giving expected data in accordance with Contract Documents, column to fill in observed data during commissioning, and space for signatures of respective Division Contractor and Commissioning Agent.
- .7 Systems Operating Manual: Manual prepared by Commissioning Agent, presenting overview of building electrical systems and equipment used by building maintenance personnel in assisting them in daily operation of systems.
- .8 Validate: Confirming by examination and witnessing tests, correctness of equipment and system operation.

1.04 COMMISSIONING AGENT

- .1 Retain services of third-party qualified Commissioning Agent with following qualifications:
 - .1 Member of Professional Engineers Association in province of Place of Work.
 - .2 Member of Building Commissioning Association, and Certified Commissioning Professional (CCP) as designated by Building Commissioning Association.
 - .3 Minimum of five years of successful documented commissioning experience on projects of similar size and complexity as this Project.
 - .4 Professional Engineer and Building Commissioning Association Certified Commissioning Professional (CCP) or ASHRAE Commissioning Project Management Professional (CPMP) onsite supervision of commissioning process.
- .2 Involvement of Commissioning Agent performing duties as described in this Section is not in any way to void or alter contractual warranty obligations.
- .3 Commissioning Agent is retained and paid by Owner to perform electrical work commissioning specified. Perform commissioning in accordance with requirements noted herein and of Owner Commissioning Agent.

1.05 COMMISSIONING OBJECTIVES

- .1 Objectives of commissioning process:
 - .1 Support quality management by means of monitoring and checking installation.
 - .2 Verify equipment/system performance by means of commissioning of completed installations.

- .3 Move completed equipment and systems from "static completion" state to "dynamic" operating state, and transferring complete and properly operating installation from Contractor to Owner and Consultant.
- .4 Review requirements for integrated testing of life safety systems and confirm compliance with CAN/ULC -S1001.
- .2 Prerequisites to successful completion of commissioning:
 - .1 Submittal of signed start-up and test reports.
 - .2 Completion and verification of electrical distribution system testing and coordination study.
 - .3 Permanent electrical and control connections of equipment.
 - .4 Successful completion and documentation of pre-functional performance testing.
 - .5 Submittal of signed letters to Consultant, certifying that systems and subsystems have been started, tested, adjusted, successfully pre-functional performance tested, are ready for functional performance testing, and are in accordance with requirements of Contract Documents.

1.06 TESTING EQUIPMENT

- .1 Supply instruments and test equipment to conduct start-up, testing, verification and commissioning procedures.

1.07 SUBMITTALS

- .1 Submit to Commissioning Agent, at same time as submittal to Consultant:
 - .1 Copy of each shop drawing or product data sheet associated with equipment or systems being commissioned.
 - .2 Commissioning Plan with schedule, commissioning procedures for commissioning events, and Commissioning Agent commissioning data sheets for equipment and systems being commissioned.
 - .3 List of commissioning instruments and for each instrument, indicating purpose of instrument and including recent calibration certificate.
 - .4 Equipment and system manufacturer start-up and test report sheets (submit minimum of one month prior to equipment and system start-up procedures).
- .2 Final Commissioning Reports:
 - .1 After start-up and successful pre-functional performance testing and submittal of completed forms, submit for each system or subsystem, signed compliance certificate confirming that pre-functional performance testing is successfully completed and system or subsystem is ready for functional performance testing and commencement of commissioning process.
 - .2 Include copies of submittals listed above and completed testing forms.
 - .3 Submit verification that integrated systems are in compliance with CAN/ULC - S1001.
 - .4 Confirm format and submission requirements for reports with Commissioning Agent.

1.08 QUALITY ASSURANCE

- .1 Perform commissioning work in accordance with:
 - .1 Respective referenced standards.

- .2 Documents of Commissioning Agent, as applicable.
- .3 Division 01, as applicable.
- .4 Specification Section requirements.
- .2 For systems such as fire alarm systems, UPS, battery energy storage systems, security systems and similar systems with proprietary type operations and controls, include for engaging respective system manufacturer qualified technicians to assist in commissioning.

2. Products (Not Used)

3. Execution

3.01 PHASING OF COMMISSIONING

- .1 Perform commissioning in phases as specified. Phase commissioning work, suiting progress and phases of work.

3.02 DEFICIENCIES LISTED DURING COMMISSIONING

- .1 Within 15 calendar days of notification unless agreed otherwise with Consultant and Commissioning Agent, correct deficiencies listed by Consultant or Commissioning Agent during commissioning process.
- .2 When deficiencies have been corrected, notify Consultant and Commissioning Agent.

3.03 SYSTEMS TO BE COMMISSIONED

- .1 Commission electrical systems as specified in Sections of Specification. Perform additional specific commissioning procedures as directed by Commissioning Agent. General commissioning procedures for typical equipment and systems include but are not limited to as listed below. Supplement with additional requirements of Commissioning Agent and AHJ.
- .2 Electrical Distribution Switchgear and Switchboards:
 - .1 Attend and witness factory testing where noted.
 - .2 Check and record nameplate data.
 - .3 Check and inspect equipment to ensure they are installed in accordance with manufacturer recommendations.
 - .4 Check installation is complete and is ready and safe to carry out testing.
 - .5 Check mechanical operation of switches and breakers.
 - .6 Check indication lights and control switches for correct functions.
 - .7 Set protection devices to correct values according to coordination study or as instructed by Consultant. Properly set protection devices prior to energization of equipment.
 - .8 Perform tests as required by Commissioning Agent.
- .3 High Voltage Cables:
 - .1 Visually inspect cable jacket, cable sheath, and insulation in cables for signs of corrosion, abrasion, mechanical damage, and overheating.
 - .2 Check for correct cable installation and termination.

- .3 Check and record cable sizes, types and method of installation.
- .4 Test for phase rotation, continuity, DC hipot, leakage current and other as recommended by cable manufacturer.
- .5 Perform tests as required by Commissioning Agent.
- .4 Motor Control Centres (MCC) and Drives:
 - .1 Check and record nameplate data.
 - .2 Check and inspect equipment to ensure it is installed in accordance with manufacturer recommendations.
 - .3 Check installation is complete and is ready and safe to carry out testing.
 - .4 Check mechanical operation of switches and breakers.
 - .5 Check connecting bolts are tightened to correct torque values.
 - .6 Check indication lights and control switches for correct functions.
 - .7 Set protection devices to correct values according to coordination study or as instructed by Consultant. Properly set protection devices prior to energization of switchboards.
 - .8 Check and set overload relays provided. Set and record overload relays to correct settings.
 - .9 Check control functions for proper functioning and connection.
 - .10 Check interface contacts for control and indications for proper functioning and connections.
 - .11 Check motor running current and readjust overload relays as necessary.
 - .12 Coordinate testing and commissioning work with Mechanical Divisions, verifying full testing and commissioning work is completed and recommended for acceptance by Consultant and Commissioning Agent.
 - .13 Perform tests as required by Commissioning Agent.
- .5 Distribution Cables:
 - .1 Check for correct cable installation and termination.
 - .2 Check and record cable sizes, types and method of installation.
 - .3 Check and confirm installed cable sizes are of adequate rating, taking into consideration of type of cable, method of installation, correction factors and any other Code requirements.
 - .4 Grounding test to ensure equipment, conduit and cable armour/sheath, where applicable, are properly grounded.
 - .5 Perform megger testing.
 - .6 Perform tests as required by Commissioning Agent.
- .6 Transformers:
 - .1 Attend and witness factory testing where noted.
 - .2 Obtain and review factory testing reports.
 - .3 Check and record nameplate data.
 - .4 Check and record sizes and types of primary and secondary protection devices, conductor sizes and types.
 - .5 Test windings on both primary and secondary terminals.
 - .6 Measure primary and secondary winding resistances.
 - .7 Sound level test for different points at 1 m away from transformers.

- .8 Energize transformers and check and record transformer voltage and load current, secondary no-load and full load. Check/calibrate primary taps to correct value. Check and record transformer on-load temperatures.
- .9 Check liquid levels of liquid filled transformers.
- .10 Take samples of oil from oil filled transformers. Test and review samples.
- .11 Test cooling fans.
- .12 Test alarms and annunciations.
- .13 Perform tests as required by Commissioning Agent.
- .7 Gensets and Enclosures:
 - .1 Attend and witness factory testing where noted.
 - .2 Obtain and review factory testing reports.
 - .3 Perform testing in accordance with CSA 282 for emergency (life safety) gensets.
 - .4 Check and record alternator, engine, control panel, switchboard, and battery nameplate data.
 - .5 Check and verify that genset and enclosure (where applicable) installations, grounding system, associated supply and exhaust air system, fuel system and room are completed prior to carrying out test.
 - .6 Perform genset site tests after complete genset installation. Installations include engines, alternators, electrical installation, fuel supply system, ventilation system, exhaust system, automatic control and indication systems, and interface with other systems installations.
 - .7 Test protective devices and circuits onsite by actually simulating a fault condition on devices.
 - .8 Test interfaces with transfer switches for correct starting, power transfer, retransfer, and shut down of gensets after power is restored.
 - .9 Test interface controls and indications with building management system, fire alarm system, elevator control system and other systems as specified.
 - .10 Dummy load test at full load operation.
 - .11 Test paralleled units, with dummy loading on gensets shared amongst gensets.
 - .12 Verify load management system confirming load priorities during load shedding.
 - .13 Load test gensets in accordance with CSA C282
 - .14 Check sound level at various loads.
 - .15 Perform tests as required by Commissioning Agent.
- .8 Auto Transfer Switches:
 - .1 Obtain and review factory testing reports.
 - .2 Check and record nameplate data.
 - .3 Check and test switch for correct alignment and correct mechanical operation of switch in different positions.
 - .4 Test electrical control, indication and interface signals with gensets, fire alarm panel, elevator control panels, building management system panel or other interface panels.
 - .5 Test for correct phase sequence and voltage.
 - .6 Perform interface test with generator for starting and stopping, in accordance with CSA C282.

- .7 Simulate power failure and verify operations are in accordance with governing code requirements (CSA C282 or CSA Z232).
- .8 Perform tests as required by Commissioning Agent.
- .9 Uninterruptible Power Supply Equipment:
 - .1 Obtain and review factory testing reports.
 - .2 Check and record nameplate data.
 - .3 Test electrical control, indications and operations in accordance with Specification requirements.
 - .4 Perform load bank test, heat run test, battery test and confirm battery back-up capacity.
 - .5 Check ventilation/cooling.
 - .6 Check condition of back-up batteries and connections.
 - .7 Check and test EPO switch for correct operation.
 - .8 Perform interface test with emergency power system.
 - .9 Simulate power failure and verify operations are as noted in Specification.
 - .10 Perform tests as required by Commissioning Agent.
- .10 Distribution Panelboards and Branch Circuit Panelboards:
 - .1 Check and record nameplate data.
 - .2 Check and test to verify panelboard directory is correct.
 - .3 Include directory in test records. Directory to contain size of each breaker, equipment served, cable type and size.
 - .4 Check and test voltage drop is within specified limit from service entrance switchboard to branch panelboards.
 - .5 Test branch circuits voltage drop is within requirements.
 - .6 Megger test branch circuits. Disconnect connected SPDs.
 - .7 Perform tests as required by Commissioning Agent.
- .11 Grounding Systems:
 - .1 Inspect grounding and ground fault protection systems.
 - .2 Perform ground continuity and ground resistivity tests using method appropriate to site conditions, approved by AHJ and reviewed with Consultant.
 - .3 Provide step-and-touch potential calculations using measured station ground resistance measurements. Document results in report.
 - .4 Test grounding and bonding systems, verifying 100% electrical continuity throughout.
 - .5 Telecommunications Systems: Test that measured resistance across individual bonding connections is 10 milliohms or less.
 - .6 Perform tests as required by Commissioning Agent.
- .12 Power System Studies and Onsite Testing:
 - .1 Review testing company prepared electrical distribution testing report, coordination study and arc fault hazard analysis report.
 - .2 Review testing company onsite testing and report findings.

- .3 Check measured and recorded fault level at service entrance switchboards, motor control centres, transformers, auto transfer switches, generator switchboard and control panels, distribution panels and branch circuit panelboards.
- .4 Check recorded and set breakers, fuse ratings and protection devices, verifying discrimination of electrical distribution system.
- .5 Review test records for measured prospective fault level and indicated fault ratings of installed equipment such as switchboards, panels, switches, breakers for above systems to confirm adequacy of fault rating of installed equipment.
- .6 Document review and include in review report.
- .7 Perform tests as required by Commissioning Agent.
- .13 Metering:
 - .1 Inspect instrumentation and communications of metering for proper connections and operations.
 - .2 Check for connections to interconnected equipment and systems.
 - .3 Check metering accuracy.
 - .4 Check metering displays.
 - .5 Check current transformers (CTs) and potential transformers (PTs) for:
 - .1 Visible cracks or other damage.
 - .2 Proper nameplate identifications of ratings and serial numbers.
 - .3 Correct ratios.
 - .4 Correct polarities.
 - .5 Correct locations.
 - .6 Correct grounding.
 - .7 Insulation resistance.
 - .8 Colour coding or labelling of wiring.
 - .9 Applicable seals provided and not broken.
 - .6 Perform tests as required by Commissioning Agent.
- .14 Lightning Protection Systems:
 - .1 Certified installer to install and verify lightning protection system as specified and in accordance to Lightning Rod Act.
 - .2 Perform ground resistance test in accordance to CSA Z8001.
 - .3 Issue certificate of approval upon completion.
- .15 Lighting and Lighting Control Systems:
 - .1 Check and verify lighting control systems and dimming systems.
 - .2 Check and verify luminaires are connected and switched properly.
 - .3 Check and verify automatic controls are connected and functioning properly.
 - .4 Check and verify emergency lighting system including battery lighting system, are connected and functioning properly.
 - .5 Confirm emergency lighting relays are UL 924 listed and that controlled emergency lighting automatically returns to full brightness, during events of loss of building power and fire alarm activations.
 - .6 Check compliance with ANSI/ASHRAE/IES Standard 90.1.
 - .7 Check and record nameplate data.

- .8 Perform lighting level tests.
- .9 Perform tests as required by Commissioning Agent.
- .16 Security Systems (Access Control and Surveillance CCTV):
 - .1 Check and record nameplate data.
 - .2 Check main panels for proper installation, wiring identification, wire harnessing, and emergency power feed.
 - .3 Test and document each type of alarm from each station, noting station numbers at which signal has been received.
 - .4 Check field devices for proper operation.
 - .5 Test specified sequences of system as specified.
 - .6 Check for integration to other systems.
 - .7 Check and report panel enclosure is suitable for environment in which it is installed.
 - .8 Perform tests as required by Commissioning Agent.
- .17 Fire Alarm System and Emergency Communications:
 - .1 Check for required ULC certificates.
 - .2 Check and record nameplate data.
 - .3 Check installation for compliance with requirements of CAN/ULC-S524.
 - .4 Check panels for proper installation, wiring identification, wire harnessing, and emergency power feed.
 - .5 Test and document each type of alarm from each device, noting device addresses at which signal has been received.
 - .6 Test and check batteries.
 - .7 Check and report panel enclosure is suitable for environment in which it is installed.
 - .8 Test specified sequences of system as specified.
 - .9 Perform system verifications and tests according to CAN/ULC-S536, CAN/ULC-S537, CAN/ULC-S561, and CAN/ULC-S1001.
 - .10 Perform tests as required by Commissioning Agent.
- .18 Battery Energy Storage Systems (BESS):
 - .1 Inspection:
 - .1 Check stacks level and anchored to the floor.
 - .2 Check bolt intercell connectors as per manufacturer details.
 - .3 Check and inspect component connections and overall installation.
 - .4 Check installation for proper grounding, fastening and alignment.
 - .5 Check communications between equipment and integrated systems.
 - .2 Start-up, Testing and Certification Work:
 - .1 Utility and interconnection standards.
 - .2 Operation of one full charge/discharge cycle.
 - .3 Data acquisition system.
 - .4 Enclosure thermal conditioning system.
 - .5 Heating and cooling systems.
 - .6 Fire Detection and Suppression System:

- .7 Confirm temperature sensor operation.
- .8 Confirm Smoke Detector Operation.
- .9 Abort button test.
- .10 Test Start Pull Station.
- .11 Test Maintenance Switch.
- .12 Fault alarm function.
- .13 Short circuit detection.
- .14 Insulation test.
- .15 Single cell voltage test.
- .16 Single cell voltage difference test.
- .17 Cell temperature difference test.
- .18 Cell temperature quantity test.
- .19 Open circuit voltage detection.
- .20 Total voltage correction.
- .21 Battery rack status indicator test.
- .22 Relay test.
- .23 Fan start-stop control test.
- .24 Emergency stop switch function test.
- .3 Confirm approvals as required by Fire Marshall and local electrical utility.
- .19 Other Systems:
 - .1 Check and record nameplate data.
 - .2 Check panels for proper installation, wiring identification, wire harnessing, and emergency power feed (as required).
 - .3 Check field devices for proper operation.
 - .4 Test specified sequences of system as specified.
 - .5 Perform tests as required by Commissioning Agent.
- .20 Perform tests on following systems, where applicable and as reviewed with Consultant and Commissioning Agent:
 - .1 Public address systems.
 - .2 Intercommunication systems.
 - .3 Clock systems.
 - .4 Audio visual systems.
 - .5 Bus duct system.
 - .6 Network structured cabling systems.
 - .7 Electric heat tracing/snow melting systems.
 - .8 Monitoring systems.
 - .9 Other systems and equipment supplied under Work of Project.
- .21 In addition to requirements of Electrical Divisions, test and commission electrical devices supplied in equipment under work of Divisions other than Electrical Divisions or through Owner.

3.04 COMMISSIONING PROCESS

- .1 Perform commissioning process unless otherwise noted in Division 01, in stages and include, but not be limited to, following:
 - .1 Stage 1: Commission Work including equipment and systems as listed in this Section, which is a prerequisite to application for Substantial Performance of the Work and includes supervising and validating results of functional performance testing, and submittal of reviewed Systems Operating Manual.
 - .2 Stage 2: Commission Work 12 months after issue of Certificate of Substantial Performance of the Work and which includes supervision of Contractor "fine tuning" of equipment and systems through seasonal occupancy, and any other such work to achieve optimal comfort and performance conditions.
 - .3 Stage 3: Successful completion of satisfactory equipment and system operation during first month after issue of Certificate of Total Performance of the Work.
 - .4 Stage 4: Successful completion of satisfactory equipment and system operation during third month after issue of Certificate of Total Performance of the Work.
 - .5 Stage 5: Successful seasonal commissioning of building.

3.05 RESPONSIBILITIES OF COMMISSIONING AGENT (UNLESS OTHERWISE NOTED IN DIVISION 01)

- .1 Agent responsibilities during construction phase:
 - .1 Review Contractor shop drawings for commissioning related issues and report such issues to Consultant.
 - .2 As Commissioning soon as possible after project start-up, prepare and issue Commissioning Plan based on Contractor construction schedule.
 - .3 Prior to tests, supply to Contractor, pre-functional performance test commissioning data sheets for equipment and systems being commissioned.
 - .4 Monitor and inspect installation on regular basis throughout construction stages. Issue reports identifying issues which may have impact on commissioning process, and work with project team to expeditiously resolve problems that may arise due to site conditions.
 - .5 Arrange with Contractor for onsite commissioning meetings on as-required basis, attended by Contractor and applicable subcontractors and Consultant. Chair meetings and prepare and distribute meeting minutes to attendees.
 - .6 Witness and validate tests, identify deficiencies, and issue progress reports.
 - .7 Coordinate commissioning scheduling with Contractor.
 - .8 Review pre-functional performance test commissioning data sheets submitted by Contractor. Witness and supervise functional performance testing and supervise and direct commissioning process. Validate commissioning procedures, witness completion of commissioning data sheets by Contractor, and sign completed data sheets.
 - .9 Perform preliminary review of Contractor O & M Manuals, before issuing to Consultant, and issue comments to Consultant.
 - .10 Coordinate with Contractor and Consultant, training and instructions by Contractor and Contractor equipment and system manufacturers/suppliers to end user operating and maintenance personnel. Comment to Consultant, on quality of training and instructions.
 - .11 Prior to equipment and system training by Contractor, prepare and issue Systems Operation Manual to Consultant.
- .2 Commissioning Agent responsibilities during post-construction phase:

- .1 Prepare and issue final report on commissioning, identifying deficiencies that remain outstanding.
- .2 Recommend training and instructions given to end user operating and maintenance personnel, in addition to training and instructions already given.
- .3 After Substantial Performance of the Work, witness system checks and validate documentation by Contractor as follows:
 - .1 Once during first month of building operation.
 - .2 Once during third month of building operation.
 - .3 Once between fourth and tenth month of building operation but during a season opposite to first or third month visits.
- .4 Verify that deficient work resulting from system checks described above are corrected by Contractor.
- .5 3 months after Substantial Performance of the Work, attend question and answer sessions with Contractor, to answer questions and concerns related to commissioning work from end users operating personnel.

3.06 RESPONSIBILITIES OF CONTRACTOR

- .1 Contractor responsibilities during construction phase:
 - .1 Prepare and submit installation schedule that includes time schedule for each activity with lead and lag time allowed and indicated, shop drawing and working detail drawing submissions, and major equipment factory testing and delivery dates.
 - .2 Prepare and submit commissioning schedule that includes time schedule coordinated with installation schedule referred to above, and allowances for additional time for re-tests as may be required. Update schedule on monthly basis as required.
 - .3 When requested by Commissioning Agent, arrange site commissioning meetings with Consultant and applicable subcontractors present. Meeting chaired by Commissioning Agent who also prepares and distributes meeting minutes.
 - .4 Correct reported deficient work, and report when corrective work is complete.
 - .5 Where required by codes, or Specification, retain equipment manufacturers/suppliers or independent third parties to certify correct installation of equipment and systems.
 - .6 Under supervision of equipment manufacturers/suppliers, start-up and adjust equipment to design requirements, and submit start-up sheets which include equipment data such as manufacturer and model number, serial number where applicable, and performance parameters, all signed by equipment manufacturer/supplier and Contractor.
 - .7 Complete Commissioning Agent commissioning data sheets for multiple items of smaller equipment. Submit sheets to Commissioning Agent and accompany Commissioning Agent for onsite check of data sheet information for each type of equipment. Perform corrective action as result of site checks.
 - .8 Perform system testing and adjusting, and when complete, issue copy of final report to Commissioning Agent for review and site check of results. Perform corrective work required as result of site checks by Commissioning Agent.

- .9 In accordance with updated commissioning schedule and actual progress at site, certify in writing to Consultant and Commissioning Agent that equipment and systems are complete, have been checked, started and adjusted, successfully pre-functional performance tested and documented, and are ready for functional performance testing and commissioning procedures. Notify Consultant and Commissioning Agent minimum of 10 working days in advance.
- .10 Perform system and subsystem functional performance testing in presence of Commissioning Agent and under supervision of Commissioning Agent, and submit to Consultant and Commissioning Agent, completed and signed functional performance testing and commissioning data sheets (issued by Commissioning Agent) and also signed by Commissioning Agent.
- .2 Contractor responsibilities during post-construction phase:
 - .1 Optimize system operation in accordance with building occupant needs and comments using System Operation Manual prepared by Commissioning Agent as reference.
 - .2 Complete commissioning procedures, activities, and performance verification procedures that were delayed or not concluded during construction phase.
 - .3 Accompanied by Commissioning Agent, complete system checks and "fine tuning" with signed documentation as follows:
 - .1 Once during first month of building operation.
 - .2 Once during third month of building operation.
 - .3 Once between fourth and tenth month in a season opposite to first and third month visits.
 - .4 Correct deficiencies revealed by system checks described above, and, where required, involve equipment manufacturers/suppliers during corrective actions, and report completion of corrective work.
 - .5 3 months after Substantial Completion of the Work conduct question and answer sessions at building with end user operating and maintenance personnel, with duration of sessions dictated by number of questions and concerns that need addressing.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI):
 - .1 ANSI C136.10-[2023], Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing.
- .2 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE C62.41.1-[2002(R2008)], IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
- .3 Underwriters Laboratories (UL):
 - .1 ANSI/UL 20-[2023], General-Use Snap Switches.
 - .2 ANSI/UL 924-[2022], Standard for Emergency Lighting and Power Equipment.
 - .3 ANSI/UL 1472-[2022], Solid-State Dimming Controls.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include following:
 - .1 Detailed design and installation drawings.
 - .2 Block wiring diagram and interconnection wiring diagrams.
 - .3 Dimming load schedules.
 - .4 Lighting panel schedules.
 - .5 Proposed sequence of operations.
 - .6 Integration drawings showing lighting system integrations to auxiliary building systems.
 - .7 Documentation from respective control device manufacturers verifying that supplied control devices are completely compatible with and able to control connected luminaires, as specified for dimming and ON/OFF functionality.
- .3 Submit testing and verification reports.

1.03 PRODUCT COMPATIBILITY

- .1 Luminaires and lighting controls integrated together for control purposes: 100% compatible for operation with each other.

- .2 Coordinate with driver and LED manufacturers, LV relay panel manufacturers, switch/timer manufacturers and dimmer/light sensor/occupancy control manufacturers to verify that components are compatible with each other and that interconnections do not adversely affect performance, life or warranties.

2. Products

2.01 PHOTOCELLS

- .1 CSA certified, 120-347 V suiting intended applications, weather-proof photo-control with features as follows:
 - .1 Completely compatible with and suiting LED driver, tungsten, magnetic and electronic ballast loads.
 - .2 Load Ratings: 8 A Electronic Ballast/LED Driver, 1000 W Tungsten, 1800 VA Ballast.
 - .3 Non-drift silicon light sensor with IR filter.
 - .4 DC relay with zero-crossing circuitry switching occurring exactly at 0 V point of voltage sine wave.
 - .5 Minimum 20-year design life and exceeds 15,000 ON/OFF switching cycles.
 - .6 Fail ON mode.
 - .7 Activation: 16 lux ON; 24 lux OFF.
 - .8 Time Delay: 2 to 5 seconds.
 - .9 MOV: 1020 J / 5,000 A surge.
 - .10 Surge Protection Level: To ANSI C136.10: 20 kV/10 kA.
 - .11 Operating Temperature Max: 60°C.
 - .12 Operating Temperature Min: Minus 30°C.
 - .13 13 mm to 14 NPSM threaded stem, fitting standard outlet boxes and wall packs.
 - .14 Mounting: Locking type, recessed in wall, stem and stem with swivel, suiting intended applications
 - .15 Adjustable photo eye sensitivity or nuisance cycling with shields or guards suiting intended applications.
- .2 Unit operates such that load remains ON when cell fails, and is complete with time delay preventing switching by artificial light.

2.02 CONTACTORS

- .1 Features:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 Pole or cabinet mounting, suiting intended applications.
 - .3 Switching multiple lamp circuits with total lighting load of 6000 W.
 - .4 Corrosion-resistant and waterproof assembly.
 - .5 Manual override.
- .2 Refer to additional requirements in Section 26 29 01 - Contactors.

2.03 MECHANICAL TIME SWITCHES

- .1 Features:

- .1 CSA certified, or ULC listed and labeled.
- .2 Adjustable, surface wall-mounted, mechanical time switch.
- .3 Astro dial, skipper, carryover, 40 ampere rated switch contacts.
- .4 Minimum NEMA 3R raintight enclosure with lockable hinged door.
- .5 Adjusts for seasonal changes automatically. Skippers omit selected dates from program. Carryover provides minimum 16 hours of preset schedule during power outages.

2.04 ELECTRONIC TIMERS

- .1 Features:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 Used for indoor applications, controls various types of lighting loads or motor loads (where occupancy sensor is not suitable or required).
 - .3 Flush-mounting into single-gang wall box.
 - .4 Solid state electronics with LCD display.
 - .5 8 interval presets.
 - .6 Tamper-resistant time-on interval can be preset.
 - .7 Flicker of lights, and audible warning begins 2 minutes before time-out.
 - .8 No minimum loads required.
 - .9 With decorator type face with matching faceplate.
- .2 Provide polycarbonate, tamper-proof, hinged locking cover on timers as noted.

2.05 STANDALONE WALL BOX DIMMERS

- .1 Features:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 Type and size to control and suit intended connected loads.
 - .3 Air gap accessible without removing faceplate, in accordance with ANSI/UL 20 short circuit test requirement for snap switches.
 - .4 Dimming in accordance with ANSI/UL 1472.
 - .5 Withstand voltage surges up to 600 V and current surges up to 200 A in accordance with IEEE C62.41.1.
 - .6 Voltage regulated.
 - .7 Power Failure Memory: Retains settings prior to loss of power.
 - .8 LC filtering to minimize RFI.
 - .9 Linear slide with smooth and continuous square law dimming curve operation.
 - .10 Snap on decorative style faceplate (seamless multi-gang at locations with multiple devices).
 - .11 Finishes: Selected from manufacturer standard finishes, as reviewed with Consultant.

2.06 DIMMING WALL SWITCH OCCUPANCY SENSORS

- .1 Dual technology dimming wall-switch sensor providing automatic control of lighting, with following features:
 - .1 CSA certified, or ULC listed and labeled.

- .2 Turn lights OFF and ON based on occupancy and allow user to increase or decrease lighting level. Factory default operation is for Manual-ON mode, allowing users to turn light on only when needed.
 - .3 Combines passive infrared (PIR) and ultrasonic occupancy detection technologies. Compatible with and works with 0-10 VDC dimming drivers and ballasts to control lighting loads including LEDs.
 - .4 120 or 347 VAC voltage operation suiting intended applications, and as noted.
 - .5 Dimming in accordance with ANSI/UL 1472.
 - .6 Variety of control options including Auto-ON operation, walk-through and test mode. Additional settings allow choice of which sensing technologies hold ON or retrigger lighting.
 - .7 Vandal resistant colour matched lens and low-profile design.
 - .8 Coverage:
 - .1 Major Motion: PIR 10 m x 9 m, Ultrasonic 6 m x 6 m.
 - .2 Minor Motion: PIR 6 m x 4.5 m, Ultrasonic 4.5 m x 4.5 m.
 - .9 Selectable walk-through mode turns lights off three minutes after room is initially occupied when no motion is detected after first 30 seconds.
 - .10 Test mode allows quick and easy verification of coverage.
 - .11 Selectable audible and visual alerts for impending shutoff.
 - .12 LED indicates occupancy detection.
 - .13 Service mode allows sensor to operate as service switch in event of failure.
 - .14 Power Failure Memory: Retains settings prior to loss of power.
 - .15 Adjustable time delays and sensitivity.
 - .16 Mounting accessories suiting intended applications.
- .2 Passive infrared (PIR) technology dimming wall switch sensor providing automatic control of lighting, with features and functionality as follows:
- .1 CSA certified, or ULC listed and labeled.
 - .2 Turn lights OFF and ON based on occupancy and allow user to increase or decrease lighting level. Factory default operation is for Manual-ON mode, allowing users to turn light on only when needed.
 - .3 Passive infrared technology and is compatible with and works with 0 to 10 VDC dimming drivers and ballasts to control lighting loads including LEDs.
 - .4 120 or 347 VAC voltage operation suiting specific project design applications, and as noted.
 - .5 Variety of control options including Auto-ON operation, walk-through and test mode. Additional settings allow choice of which sensing technologies hold ON or retrigger lighting.
 - .6 Vandal resistant colour matched lens and low-profile design.
 - .7 Coverage:
 - .1 Major Motion: 10 m x 9 m.
 - .2 Minor Motion: 6 m x 4.5 m.
 - .8 Selectable walk-through mode turns lights off three minutes after room is initially occupied when no motion is detected after first 30 seconds.
 - .9 Test mode allows quick and easy verification of coverage.
 - .10 Selectable audible and visual alerts for impending shutoff.
 - .11 LED indicates occupancy detection.

- .12 Service mode allows sensor to operate as service switch in event of failure.
- .13 Power Failure Memory: Retains settings prior to loss of power.
- .14 Adjustable time delays and sensitivity.
- .15 Mounting accessories suiting intended applications.

2.07 ANALOGUE TYPE OCCUPANCY SENSORS AND ASSOCIATED DEVICES

- .1 Analogue type control devices and accessories, providing automatic control of lighting, as follows:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 Power and slave packs.
 - .3 Occupancy sensors.
 - .4 Controls and daylight sensors.
 - .5 Ancillary devices.
 - .6 Wiring in conduit and mounting hardware.
- .2 Ultrasonic technology type ceiling-mounted occupancy sensors as follows:
 - .1 Line voltage and low voltage operation, suiting intended applications and as noted.
 - .2 When ultrasonic technology detects occupancy, lights turn ON automatically; once lights are ON, detection holds lights ON until occupancy is no longer detected and time delay elapses.
 - .3 Coverage:
 - .1 General Areas: 360 degrees dispersion lens coverage to suit space, up to 185 m².
 - .2 Corridor Applications: Linear lens area coverage, extending out up to 13.5 m in 2 directions.
 - .4 Low profile ceiling mounting design.
 - .5 Integral light sensor.
 - .6 Adjustable digital time delay.
 - .7 LED indication of occupancy detection.
 - .8 Isolated relay for interconnection to auxiliary control systems.
 - .9 Mounting accessories suiting intended applications.
- .3 PIR technology type ceiling-mounted occupancy sensors as follows:
 - .1 Line or low voltage operation suiting intended applications.
 - .2 Coverage: 360° lens area coverage, extending out up to 13 m and area of 111 m².
 - .3 Low profile ceiling mounting design.
 - .4 Passive infrared technologies.
 - .5 Integral light sensor.
 - .6 Adjustable sensitivity and digital time delay.
 - .7 Walk-through mode.
 - .8 LED indication of occupancy detection.
 - .9 Isolated relay for interconnection to auxiliary control systems.
 - .10 Mounting accessories suiting intended applications.

- .4 Dual technology type ceiling-mounted occupancy sensors as follows:
 - .1 Line or low voltage operation suiting intended applications and as noted.
 - .2 Combination passive infrared and ultrasonic technologies.
 - .3 When both PIR and ultrasonic technologies detect occupancy, lights turn ON automatically. Once lights are ON, detection by either technology holds lights ON until occupancy is no longer detected and time delay elapses.
 - .4 360° lens area coverage, extending out up to 6 m and area of 92.9 m².
 - .5 DIP switches for setup.
 - .6 Low profile ceiling mounting design.
 - .7 Integral light sensor.
 - .8 Adjustable sensitivity and digital time delay.
 - .9 Walk-through mode.
 - .10 LED indication of occupancy detection.
 - .11 Isolated relay for interconnection to auxiliary control systems suiting intended applications.
 - .12 With mounting accessories suiting intended applications.
- .5 Ceiling/wall corners mounted dual technology occupancy sensors as follows:
 - .1 Line or low voltage operation suiting intended applications and as noted.
 - .2 Combination passive infrared and ultrasonic technologies.
 - .3 When both PIR and ultrasonic technologies detect occupancy, lights turn ON automatically. Once lights are ON, detection by either technology holds lights ON until occupancy is no longer detected and time delay elapses.
 - .4 With adjustable swivel mounting bracket.
 - .5 Wide dispersion lens area coverage, extending out up to 16 m and area of 185 m².
 - .6 DIP switches for setup.
 - .7 Low profile design.
 - .8 Integral light sensor.
 - .9 Adjustable sensitivity and digital time delay.
 - .10 Walk-through mode.
 - .11 LED indication of occupancy detection.
 - .12 Isolated relay for interconnection to auxiliary control systems suiting intended applications.
 - .13 Mounting accessories suiting intended applications.
- .6 Applications in washrooms and small storage rooms: Wall-mounted dual technology occupancy sensors as follows:
 - .1 Line or low voltage operation suiting intended applications and as noted.
 - .2 Combination passive infrared and ultrasonic technologies.
 - .3 Wall switch sensor turns lights OFF and ON based on occupancy.
 - .4 Factory default operation is for Manual-ON mode, allowing users to turn light on only when needed.
 - .5 Variety of control options including Auto-ON operation, walk-through and test mode. Additional settings allow choice of which sensing technologies hold ON or retrigger lighting.

- .6 Coverage: Wide dispersion lens area coverage, extending out up to 10 m and area of 37 m².
- .7 Manual pushbutton operation (override).
- .8 Colour matched vandal-resistant lens and low-profile design.
- .9 Integral light sensor.
- .10 Adjustable sensitivity and digital time delay.
- .11 LED indication of occupancy detection.
- .12 Mounting accessories suiting intended applications.
- .7 Applications for control of two lighting loads: Provide dual relays interconnected to devices and luminaires, for controlling 2 independent light loads or circuits.
- .8 Outdoor control of lighting, outdoor motion sensors as follows:
 - .1 Line or low voltage operation suiting intended applications and as noted.
 - .2 Weatherproof and raintight enclosure.
 - .3 Operating temperature from minus 40°C to 54°C.
 - .4 Adjustable head.
 - .5 Coverage: Minimum 270°.
 - .6 Adjustable light level from 5.4 lux to 2150 lux.
 - .7 Isolated relay with NO and NC outputs.
 - .8 13 mm threaded conduit nipple for attachment to standard weatherproof electrical box with faceplate.
- .9 Power packs as follows:
 - .1 Self-contained, 347/120 VAC/24 VDC, transformer relay system, suiting intended applications and as noted.
 - .2 Slave packs contain isolated relay. System allows one sensor to control luminaires circuited to both essential power circuits and normal power circuits.
 - .3 Mechanically held latching relay with selectable power loss operation: On, Off, or last state.
 - .4 Dry contacts rated for switching intended load types.
 - .5 Switches lighting or plug loads On and Off in response to low voltage control inputs.
 - .6 Enables Manual-On sequences of operation, as well as Hold-On, Hold-Off, load shed applications and bi-level switching.
 - .7 Field-selectable Auto-On or Manual-On operation.
 - .8 Short circuit, over-current and thermal protection.
 - .9 LED indicates status of relay or presence of low voltage overcurrent.
 - .10 Plenum rated.
- .10 Day light sensors as follows:
 - .1 Photosensor is self-contained, ceiling-mounted daylighting control device that detects changes in light levels and raises or lowers connected luminaires in response.
 - .2 Closed loop device that measures both daylight contribution and controlled luminaires contribution.
 - .3 Low voltage device, capable of controlling up to 50 standard 0 to 10 VDC electronic dimming ballasts.

- .4 With linear response greater than 1% accuracy over sensed range.
- .5 Internal photocell measures only in visible spectrum and with response curve that closely matches photopic curve and does not measure energy in either ultraviolet or infrared spectrums. Sensitivity of less than 5% for wavelengths less than 400 nanometers or greater than 700 nanometers.
- .6 Dimming over full range from 0.2 VDC to 10 VDC.
- .7 Sliding setpoint algorithm to maintain desired task level illuminance for current daylight contribution based on two setpoints, a night setpoint and a day setpoint.
- .8 Setup adjustments made remotely from photosensor by means of wireless, infrared handheld remote.
- .9 Controllable by compatible handheld remote that allows user to adjust light level while enabling automatic dimming to continue to achieve adjusted setpoint.
- .10 Control range of 210 to 640 lux.
- .11 Not protrude more than 20 mm from ceiling and to blend in aesthetically.
- .11 Override switches as follows:
 - .1 Connects to system and sensors allowing for manual bypassing control and retaining luminaires either ON or OFF, suiting intended applications.
 - .2 Low voltage push button or line voltage toggle switch, suiting intended applications and as noted.
 - .3 Matching decorative style faceplates, finished as reviewed with Consultant.
 - .4 Wall-mounting in single gang recessed outlet boxes.
- .12 System General Requirements:
 - .1 Provide day light sensors for dimming or controlling lights in areas of windows and atriums and sky lights.
 - .2 Provide fire alarm interface module to interconnect fire alarm such that activation of fire alarm initiates lighting control system to go into emergency sequence, typically raising dimmed lighting to full brightness and returning lighting levels back to levels before fire alarm event.
 - .3 Provide relays to integrate sensors to BAS. Coordinate exact requirements with lighting control products vendor and Division 25 BAS vendor.
 - .4 Provide wiring in conduit, interconnecting wiring, mounting hardware and ancillary devices in accordance with manufacturer requirements to complete system installation.
 - .5 Include for and arrange for manufacturer authorized representative to perform on site testing, verification and certification of installed system. Refer to Part 3 for additional requirements.
 - .6 Where sensors are interconnected to dimming system, verify that they are 100% compatible with respective control systems, dimmers and ballasts. Review with respective equipment manufacturers and obtain in writing that such integrations are acceptable to each manufacturer.
 - .7 When sizing system components capacities, include for minimum 20% future spare capacity.

2.08 WIRELESS SENSORS AND ASSOCIATED DEVICES

- .1 Wireless lighting control devices general requirements:
 - .1 CSA certified, or ULC listed and labeled.

- .2 Industry Canada certified.
- .3 Communication operating frequency in compliance with and having approval of AHJ. Devices operate at same operating frequency.
- .4 Operating Temperature of Devices: From 0°C to 50°C.
- .2 Receivers:
 - .1 Features:
 - .1 Receives signals from RF self-powered sensors, switches, and other transmitters to control lighting, and other devices or loads.
 - .2 RF technologies with range from 15 m to 45 m and suiting intended applications.
 - .3 Capacity to control and memory store identifications of up to 25 transmitters in range.
 - .4 Rated for up to 20 A of lighting loads and 746 W of motor loads.
 - .5 Power input: 120 VAC, 60 Hz.
- .3 Dimming Controllers:
 - .1 Features:
 - .1 1 to 10 V dimming controllers adjusts brightness of compatible fluorescent ballasts and LED drivers by responding to wireless signals from self-powered wireless entry stations, wireless sensors and central controllers.
 - .2 Dimming in accordance with ANSI/UL 1472.
 - .3 RF technologies with range from 15 m to 45 m.
 - .4 Capacity to control and memory store identifications of up to 25 transmitters in range.
 - .5 Area dimming controller includes isolated contacts providing connection from alternate hardwired control devices.
 - .6 Rated for up to 20 A of lighting loads and 746 W of motor loads.
 - .7 Output channels: Latching form A relay, selectable N.O. or N.C. power up state and 1 to 10 V output signal.
 - .8 Power input: 120 VAC, 60 Hz.
- .4 Occupancy Sensors:
 - .1 Passive infrared (PIR) surface mount occupancy sensors with features as follows:
 - .1 RF technologies with range from 15 m to 45 m and suiting intended applications.
 - .2 Self-powered and self-charging.
 - .3 Built-in solar cells that power themselves with ambient light and can operate for up to 70 hours in total darkness.
 - .4 Self-powered technology enables sensor operation after 2 minutes at 200 lux.
 - .5 Batteries not required, but with user option for use with batteries.
 - .6 Fresnel lens.
 - .7 Field-Of View:
 - .1 Ceiling-Mounted Type:

- .1 360 degrees field of view coverage extending out minimum 4.5 m with area of coverage at least 110 m².
 - .2 Wall-Mounted Type:
 - .1 Swappable wide angle and long-range lenses.
 - .2 Wide Angle Lens: Extends out at least 14 m coverage; 180 m² minor and 360 m² major.
 - .3 Long Range Lens: Extends out at least 45 m coverage; 300 m² minor and 600 m² major.
 - .2 Select appropriate sensor type and lens, suiting intended applications, and as recommended by system manufacturer.
- .5 Light Sensors:
 - .1 Surface mount daylight sensors with features as follows:
 - .1 Integral photocells.
 - .2 RF technologies with range from 6 m to 35 m.
 - .3 Self-powered and self-charging.
 - .4 Built-in solar cells that power themselves with ambient light and can operate for up to 70 hours in total darkness.
 - .5 Minimum light required 40 lux.
 - .6 Solar cell operating range from 10 to 10,000 lux.
 - .7 Measurement range from 0 to 1000 lux.
 - .8 Self-powered technology enables sensor to operate after 1 minute at 200 lux.
 - .9 Batteries not required, but with user option for use with batteries.
 - .10 Fresnel lens.
 - .11 Field-of View: 60 degrees cone.
- .6 Devices Mounted on Luminaires:
 - .1 As noted in Luminaire Schedule, wireless RF type receivers are integrated into body of luminaires and are connected to luminaires. Features include:
 - .1 Wired connections to luminaires for communications and power, typically low voltage operation.
 - .2 Type suiting application and installed on luminaire as coordinated with luminaire manufacturer.
 - .3 Aesthetics of device to match and coordinate with luminaire.

2.09 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Photocells and Timers:
 - .1 Intermatic.
 - .2 Paragon Electric.
 - .3 Tork.
- .2 Standalone Wall Box Dimmers:
 - .1 Lutron.
- .3 Lighting Control Systems:
 - .1 Acuity.

- .2 Legrand (Watt Stopper).
- .3 Lutron.
- .4 Leviton.
- .5 Hubbell.
- .6 Signify.
- .7 Cooper (Fifth Light).
- .8 Osram (Encelium).

3. Execution

3.01 INSTALLATION OF OUTSIDE LIGHTING CONTROL

- .1 Provide photocell to switch designated outside lighting on, and time switch for programmed "off" control. Provide relays/contactors for control connections to multiple lighting loads. Refer to drawing details and notes for supplementary requirements. Provide wiring in conduit and system connections to complete outside lighting control installation.
- .2 Prior to roughing-in, review locations and mounting heights of components with Consultant.
- .3 Prior to start of Work, review sequence of operation with Consultant.
- .4 Install components in accordance with manufacturer instructions suiting intended installation applications.
- .5 Flush-mount photocell in north exterior wall of building unless otherwise noted, at height permitting cleaning.
- .6 Connect lighting circuits to photocell and to time switch located adjacent panelboard of connected lighting circuits.

3.02 INSTALLATION OF TIMERS

- .1 Provide timers to control lighting and other equipment.
- .2 Review with manufacturer representative, exact type of timers to verify proper compatibility to interconnected equipment and loads.
- .3 Install devices in accordance with manufacturer instructions. Provide wiring in conduit. Provide power connections and interconnection to luminaires, equipment, and power panels.
- .4 Programme timers in accordance with schedule reviewed with Consultant.
- .5 Provide engraved nameplate identifying each timer. Review nomenclature with Consultant.

3.03 INSTALLATION OF WALL BOX DIMMERS

- .1 Provide flush wall box dimmers in locations and connect to control lighting. Equip each dimmer with faceplate.
- .2 Install components in accordance with manufacturer instructions, suiting intended installation applications.
- .3 Prior to roughing-in, review locations with Consultant.

- .4 Prior to ordering, review device colour and finish with Consultant.
- .5 Where noted, provide enclosure cabinet for mounting grouped dimmers and connect complete. Refer to drawings for additional requirements. Clearly identify each dimmer and enclosure with engrave Lamacoid nameplates. Review exact nomenclature with Consultant prior to ordering.

3.04 INSTALLATION OF DIMMING WALL SWITCH OCCUPANCY SENSORS

- .1 Provide flush wall box dimmer occupancy sensors in locations and connect to control lighting. Equip each dimmer with faceplate.
- .2 Prior to installation, review device settings for automatic or manual on, and delay-off, with Consultant. Adjust settings on each device.
- .3 Prior to roughing-in, review locations with Consultant.
- .4 Prior to ordering, review device colour and finish with Consultant.
- .5 Install components in accordance with manufacturer instructions, suiting intended installation applications.

3.05 INSTALLATION OF OCCUPANCY SENSORS AND ASSOCIATED DEVICES

- .1 Provide occupancy sensors and daylight sensors and associated devices to control lighting in areas. Provide power packs of voltage and power ratings for specific applications.
- .2 Review with product vendor, exact type of occupancy sensors and type of lenses to verify proper coverage in sensed areas only, and compatibility to interconnected systems.
- .3 Prior to installation, review device settings for automatic or manual on, and delay-off, with Consultant. Adjust settings on each device.
- .4 Prior to roughing-in, review locations and mounting heights with manufacturer and Consultant.
- .5 Prior to ordering, review device colour and finish with Consultant.
- .6 Provide, locate and aim sensors in correct location required for volumetric coverage within range of coverages of controlled areas in accordance with manufacturer recommendations. Install sensors in rooms to provide 90 to 100% coverage of controlled area to accommodate occupancy habits of occupants within rooms. Locations and quantities of sensors shown are illustrations only and be used as guidelines. Provide additional sensors to provide coverage in respective rooms.
- .7 Verify with manufacturer representative, exact type of sensor used in each area, placement of sensors and installation criteria, to best meet requirements of end user. Review with manufacturer representative for more non-typical installation types. Verify that sensors connected to dimming system are 100% compatible with dimming system.
- .8 Install devices to overcome local difficulties due to space limitations or overcome interference of structural components. Provide onsite training necessary to familiarize users with operation, use, adjustment, and problem-solving diagnosis of occupancy sensing devices and systems.
- .9 Provide daylight sensors for dimming or controlling lights:
 - .1 In areas of windows.
 - .2 In areas of atriums/sky lights.
 - .3 Where noted.

- .10 Install and connect power supplies.
- .11 Where both normal and emergency power circuited luminaires exist, provide emergency power control unit and relays, that allows sensor to control both emergency power circuited luminaires and normal power circuited luminaires. When normal power is lost, emergency power circuited luminaires are in operation.
- .12 Install components in accordance with manufacturer instructions, suiting intended installation applications.
- .13 Provide wiring in conduit. Provide power connections and interconnection to luminaires and power panels. Provide manual switches to override control system in each controlled area and room.
- .14 Adjust sensitivity and time delays to best suit furniture layout drawings. Allow for minor adjustments of locations before surface finishing is complete, up to 1 m for sensors.
- .15 After completion of project and within 30 days after takeover and furnishings are in place, provide for manufacturer representative to revisit site to test and make final adjustments.

3.06 INSTALLATION OF WIRELESS DEVICES

- .1 Install system of integrated wireless lighting control devices.
- .2 Verify with manufacturer representative, exact type of sensor used in each area, and placement of sensors and installation criteria, to best meet requirements of end user. Review with manufacturer representative for more non-typical installation types. Verify that sensors connected to dimming system are 100% compatible with dimming system.
- .3 Install components in accordance with manufacturer instructions, suiting intended installation applications.
- .4 Prior to installation, review device settings for automatic or manual on, and delay-off, with Consultant. Adjust settings on each device.
- .5 Prior to roughing-in, review locations and mounting heights with manufacturer and Consultant.
- .6 Prior to ordering, review device colours and finishes with Consultant.
- .7 Provide, locate and aim sensors in correct location required for volumetric coverage within range of coverages of controlled areas in accordance with manufacturer recommendations. Install sensors in rooms to provide 90 to 100% coverage of controlled area to accommodate occupancy habits of occupants within rooms. Locations and quantities of sensors shown are illustrations only and be used as guidelines. Provide additional sensors to provide coverage in respective rooms.
- .8 Install devices to overcome local difficulties due to space limitations or overcome interference of structural components. Provide onsite training necessary to familiarize users with operation, use, adjustment, and problem-solving diagnosis of occupancy sensing devices and systems.
- .9 Install and connect power supplies.
- .10 Provide remote controls and programme providing operations as reviewed with Consultant.
- .11 Where both normal and emergency power circuited luminaires exist, provide emergency power control unit and relays, that allows sensor to control both emergency power circuited luminaires and normal power circuited luminaires. When normal power is lost, emergency power circuited luminaires are in operation.

- .12 Provide power connections and interconnection. Run installed wiring in conduit.
- .13 Adjust sensitivity and time delays to best suit furniture layout drawings. Allow for minor adjustments of locations before surface finishing is complete, up to 1 m for sensors.
- .14 After completion of project and within 30 days after takeover and furnishings are in place, provide for manufacturer representative to revisit site to test and make final adjustments.

3.07 IDENTIFICATION

- .1 Identify equipment with nameplates and clearly label low voltage circuits.
- .2 Identification Labels: Size 2 unless otherwise noted, indicating ratings and system name.

3.08 FIELD QUALITY CONTROL

- .1 Services of Manufacturer Authorized Technician:
 - .1 Custom system programming.
 - .2 Inspection of installed system.
 - .3 Adjustments.
 - .4 Start-up procedures.
 - .5 Certify system equipment and operation.
- .2 Inspection, Start-up, Testing and Verification:
 - .1 Inspect, start-up, test and verify products.
 - .2 Verify that each dimmer is sized and of type suiting connected load.
 - .3 Adjust and preset devices in accordance with Consultant recommendations.
 - .4 Adjust sensitivity and time delays to best suit furniture layout drawings. Allow for minor adjustments of locations before surface finishing is complete, up to 1 m for sensors.
 - .5 Check connections. Test and check operation of each device.
 - .6 Indicate in reports, final setting of devices.
- .3 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include:
 - .1 Interlocks and keys.
 - .2 Identification of stamped coding for cylinders and keys.
 - .3 Sequence of operations.
- .3 Submit documented listing of interlocks and proposed sequence of operations.
- .4 Submit testing and verification reports.

2. Products

2.01 INTERLOCK HARDWARE

- .1 Mechanical type, trapped key interlocks with features as follows:
 - .1 Type suiting intended application and physically fit equipment, as reviewed with manufacturer of equipment being interlocked and reviewed with Consultant.
 - .2 Comprised of brass interlock housing and 303 stainless steel lock bolts.
 - .3 7- pin nickel-silver key with brass 7-pin tumbler lock cylinder.
 - .4 Keys duplicated only by manufacturer and include "DO NOT DUPLICATE" stamped on keys.
 - .5 Key interchange code of characters stamped on keys and cylinder, as reviewed with Consultant. Initially assume "C" code until final review with Consultant.
 - .6 Cylinder combination number stamped on keys and cylinder.
 - .7 Key way designation stamped on keys.
 - .8 Nameplate.
 - .9 Identification tag warning of required sequence of operation.
 - .10 Accessories and mounting hardware suiting intended applications.
 - .11 Corrosion resistant features where installed in non-climate-controlled areas.

2.02 INTERLOCK SYSTEMS – SEQUENCES OF OPERATIONS

- .1 Mechanical interlocks between two power circuit breakers located in switchgear, switchboards or distribution panels, preventing:
 - .1 Alternate power breaker closing unless designated source power breaker is open.

- .2 Designated source power breaker closing unless alternate power breaker is open.
- .2 Electrical interlock between two power sources in double-ended switchgear or switchboard, preventing:
 - .1 Bus tie power breakers closing unless one of supply source power breaker is open.
 - .2 Supply source power breaker closing unless bus tie power breakers are open.
 - .3 Alternate source power breaker closing unless designated source power breaker is open.
 - .4 Designated source power breaker closing unless alternate source power breaker is open.
- .3 Mechanical key interlocks, Type F for load interrupter switch and Type D for switchgear cubicle door, preventing:
 - .1 Opening cubicle door for access to fuses while load interrupter is in closed position.
 - .2 Closing load interrupter while cubicle door is open.
- .4 Mechanical key interlocks Type F for main circuit breaker and Type F for group operated cross-arm-mounted isolating switch, preventing:
 - .1 Opening isolating switch while main circuit breaker is closed.
 - .2 Closing circuit breaker while isolating switch is open.
- .5 Mechanical key interlocks, Type T, key transfer, preventing:
 - .1 Opening isolating switch until each circuit breaker, load interrupter, or both, is open. Refer to drawings for additional requirements.
 - .2 Closing circuit breakers or load interrupters while isolating switch is open. Refer to drawings for additional requirements.
- .6 Mechanical key interlocks, Type F for circuit breaker and Type D for gate in transformer vault, preventing:
 - .1 Opening of vault gate while circuit breaker is closed.
 - .2 Closing of circuit breaker while gate is open.
- .7 Mechanical key interlocks Type F for designated source power breaker and alternate power breaker, preventing:
 - .1 Alternate source power breaker closing unless designated source power breaker is open.
 - .2 Designated source power breaker closing unless alternate source power breaker is open.
- .8 Key interlocks mounted in switchgear, switchboards or distribution panels so that interlocks cannot be removed when operating mechanism, breaker or switch is in closed position. Refer to drawings for sequence of operation requirements.

2.03 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Interlock Systems:
 - .1 Kirk Key Interlock.
 - .2 Rockwell Automation (Allen-Bradley).

3. Execution

3.01 INSTALLATION

- .1 Provide interlocking products and sequence of operations. Where interlocks are installed on equipment, equipment manufacturer is responsible for providing interlocks, unless otherwise noted.
- .2 Prior to ordering, review stamped coding for cylinders and keys, and review sequence of operations with Consultant.
- .3 Determine locking bolt length, number of interlocks and cylinders, key removable option, mounting hardware and sequence of operation, suiting intended applications. Refer to drawings for supplementary requirements.
- .4 Install devices in accordance with manufacturer instructions, suiting intended applications and sequence of operations. Coordinate installation with manufacturer of equipment in which interlocks are installed. Provide type suitable for mounting and provide required hardware.
- .5 Provide identification warning tag with nomenclature reviewed with Consultant.
- .6 Refer to additional requirements as noted.
- .7 Label and identify interlocks and sequence of operation.

3.02 FIELD QUALITY CONTROL

- .1 Inspection, Testing and Verification:
 - .1 Inspect, test and verify products.
 - .2 Check connections and operations.
- .2 Document identification of interlocks, identifying each interlock and key, and sequence of operation in report.
- .3 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards (ANSI):
 - .1 ANSI Z535.1-[2022], American National Standard for Safety Colours.
- .2 CSA Group (CSA):
 - .1 CSA C9-[17], Dry-Type Transformers.
 - .2 CSA C22.2 No. 47-[13(R2018)], Air-Cooled Transformers (Dry Type).
 - .3 CAN/CSA-C802.2-[18], Test Method and Minimum Efficiency Values for Dry-Type Transformers.
- .3 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE C57.110-[2018], IEEE Recommended Practice for Establishing Liquid Immersed and Dry-Type Power and Distribution Transformer Capability when Supplying Nonsinusoidal Load Currents.
- .4 Government of Canada:
 - .1 SOR/2016-311-[2019], Energy Efficiency Regulations, 2016.
- .5 Government of Ontario:
 - .1 Green Energy Repeal Act, [2018].
 - .2 O. Reg. 509/18-[2021], Energy And Water Efficiency - Appliances and Products.
- .6 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA ST 20-[2021], Dry Type Transformers for General Applications.
- .7 U.S. Department of Energy (DOE) / Code of Federal Regulations (CFR):
 - .1 DOE 2016-[2022] – CFR Title 10/Chapter II/Subchapter D/ Part 431 Energy Efficiency Program for Certain Commercial and Industrial Equipment, Subpart K - Distribution Transformers.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Indicate on drawings:
 - .1 Dimensions showing enclosure, mounting devices, terminals, taps, internal and external component layout.
 - .2 Technical Data:
 - .1 kVA rating.
 - .2 Primary and secondary voltages.

- .3 Frequency.
 - .4 Number of phases.
 - .5 Polarity or angular displacement.
 - .6 Full load efficiency.
 - .7 Regulation at unity pf.
 - .8 BIL.
 - .9 Insulation type.
 - .10 Sound rating.
- .3 Submit testing and verification reports.

2. Products

2.01 LOW VOLTAGE DRY TYPE DISTRIBUTION TRANSFORMERS – GENERAL REQUIREMENTS

- .1 Types, Capacities and Ratings: As noted.
- .2 Standards:
 - .1 CSA certified, ULC listed and labeled.
 - .2 Constructed and factory tested in accordance with applicable requirements of following:
 - .1 CSA C9.
 - .2 CSA C22.2 No. 47.
 - .3 CAN/CSA-C802.2.
 - .4 DOE 2016.
 - .5 Green Energy Repeal Act.
 - .6 O. Reg. 509/18.
 - .7 NEMA ST 20.
 - .8 SOR/2016-311.
- .3 Provide transformers from same manufacturer throughout Project.
- .4 Include hardware and supports for floor-mounting, wall-mounting, or suspended from ceiling. Refer to drawings.
- .5 Modules/Contacts: For integration to BAS, to monitor transformer over-temperature, where noted.
- .6 Aluminum Nameplates:
 - .1 Riveted to front of enclosure.
 - .2 With following identification:
 - .1 Electrical ratings, primary and secondary voltage levels, impedance rating, weight, style and serial number.
 - .2 Connection diagram and CSA certification mark.
- .7 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and transformer manufacturer recommendations.

2.02 GENERAL LOW VOLTAGE DRY TYPE TRANSFORMERS

- .1 Transformers Features:
 - .1 Copper windings.
 - .2 Class "H", 220°C class, coil insulation, such that winding temperature rise to not exceed 150 C° and enclosure temperature rise not exceed 65 C° under full load in 40°C ambient temperature.
 - .3 Core construction consisting of stacked laminations of high permeability silicone steel.
 - .4 Vacuum impregnated polyester or epoxy-resin types.
 - .5 Lugs or pressure type terminals suiting primary and secondary conductors.
 - .6 Voltage Taps:
 - .1 Up to 15 kVA: Two - 5% full capacity taps, one above normal and one below normal. Taps located on primary winding.
 - .2 Greater than 15 kVA: Four - 2-1/2% full capacity taps, two above normal and two below normal. Taps located on primary winding.
 - .7 Integral vibration dampening system with anti-vibration pads used between coil and core and enclosure.
 - .8 Basic impulse level: In accordance with CSA C9, unless otherwise noted.
 - .9 Average sound level: In accordance with NEMA ST 20 and CSA C9, unless otherwise noted.
 - .10 Average Sound Level: Where noted, low sound noise of minus 3 db below requirements of NEMA ST 20 and CSA C9.
 - .11 Efficiency meeting or exceeding latest efficiency levels of referenced standards listed above including CAN/CSA-C802.2.
 - .12 Flexible copper grounding strap, grounding core and coil assembly to enclosure.

2.03 K-RATED LOW VOLTAGE DRY TYPE TRANSFORMERS

- .1 K rated transformers features:
 - .1 Copper windings.
 - .2 Class "H", 220°C class, coil insulation, such that winding temperature rise to not exceed 150 C° and enclosure temperature rise not exceed 65 C° under full load in 40°C ambient temperature.
 - .3 Core construction consisting of stacked laminations of high permeability silicone steel.
 - .4 Vacuum impregnated polyester or epoxy resin.
 - .5 K factor 13 rating in accordance with IEEE C57.110.
 - .6 Electrostatic shielding: Single shield providing 60dB of common mode noise attenuation from 100 Hz through 1 MHz.
 - .7 Neutral sized for twice rated current.
 - .8 Lugs or pressure type terminals to suit primary and secondary conductors.
 - .9 Voltage Taps:
 - .1 Up to 15 kVA: Two - 5% full capacity taps, one above normal and one below normal. Taps located on primary winding.
 - .2 Greater than 15 kVA: Four - 2-1/2% full capacity taps, two above normal and two below normal. Taps located on primary winding.
 - .10 Integral vibration dampening system with anti-vibration pads used between coil and core and enclosure.

- .11 Basic impulse level: In accordance with CSA C9, unless otherwise noted.
- .12 Average Sound Level: In accordance with NEMA ST 20 and CSA C9, unless otherwise noted.
- .13 Average Sound Level: Where noted, low sound noise of minus 3 db below requirements of NEMA ST 20 and CSA C9.
- .14 Efficiency meeting or exceeding latest efficiency levels of referenced standards listed above including CAN/CSA-C802.2.
- .15 Flexible copper grounding strap grounding core and coil assembly to enclosure.

2.04 ENCLOSURES AND DRIP SHIELDS

- .1 Standard Indoor Applications: Unless otherwise noted, minimum NEMA 2 ventilated, drip proof enclosure with rigid end frame, removable plates, terminal compartment.
- .2 Sprinklered Areas: Unless otherwise noted, minimum NEMA 3R enclosure with rigid end frame, removable plates, terminal compartment; ventilation louvres designed preventing penetration of water spray from activated sprinklers onto live parts, and gasketed doors and component openings.
- .3 Indoor Industrial Applications: Unless otherwise noted, minimum NEMA 12 non-ventilated, drip proof, dust-tight enclosure with rigid end frame, removable plates, terminal compartment.
- .4 Outdoor Applications: Unless otherwise noted, minimum NEMA 4 non-ventilated, water-tight enclosure.
- .5 Top-mounted factory painted drip shield for indoor enclosures.
- .6 Bottom-mounted drip tray for wall/ceiling mounted transformers.
- .7 Factory painted with ANSI grey enamel finish, as reviewed with Consultant.

2.05 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 General and K-Rated Dry Type Transformers:
 - .1 Hammond Power Solutions.
 - .2 Delta Group.
 - .3 Schneider Electric.
 - .4 REX Power Magnetics.
 - .5 Siemens.
 - .6 STI.
 - .7 Eaton.
 - .8 ABB.
 - .9 Hitachi.
- .2 Harmonic Mitigating Transformers:
 - .1 Hammond Power Solutions.
 - .2 Delta Group.
 - .3 Mirus International.
 - .4 Powersmiths International.
 - .5 ABB.
 - .6 Hitachi.

3. Execution

3.01 INSTALLATION

- .1 Locate transformers into position. Install with clearance space for access for operation and maintenance. Provide ventilation for transformers to operate as specified and that there is no transfer of heat to adjacent surfaces or equipment. Install in accordance with manufacturer instructions and recommendations.
- .2 Unless otherwise noted, secure transformers 75 KVA and larger to concrete housekeeping pad on vibration isolation pads.
- .3 Unless otherwise noted, secure transformers smaller than 75 KVA in place on angle wall mounting bracket support assembly located approximately 300 mm below ceiling. Provide support assembly and secure to wall and/or ceiling construction.
- .4 Provide seismic restraints as specified.
- .5 Install transformers in level upright position.
- .6 Remove shipping supports only after transformer is installed and just before putting into service.
- .7 Loosen isolation pad bolts until no compression is visible.
- .8 Make primary and secondary connections in accordance with manufacturer wiring diagram.
- .9 Equip transformers with lugs or connections suitable for primary and secondary connections. Provide factory installed lugs for dual output transformers where noted. Isolate primary and secondary connections from transformer enclosures by means of 300 mm to 450 mm length of liquid-tight flexible conduit. Typically, install conduit connections in lower one-third of transformer.
- .10 Ground and bond equipment to ground electrode grids.
- .11 Seal openings and conduit entries of enclosures and drip shield, watertight.
- .12 Prior to ordering, review finish colours of enclosure with Consultant.
- .13 Provide equipment main identification nameplates of size 4 unless otherwise noted.

3.02 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing, Commissioning and Verification:
 - .1 Perform inspection, start-up procedures, and testing as recommended by manufacturer.
 - .2 Test and commission equipment.
 - .3 Test and check secondary voltages.
 - .4 Make required adjustments and verify secondary voltage readings and identify adjustments made to achieve proper voltages.
 - .5 When building is in normal use, re-check voltages and make required adjustments.
- .2 Prepare test and verification reports, signed by test technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C61869-1-[14(R2019)], Instrument Transformers - Part 1: General Requirements (Adopted IEC 61869-1:2007, Edition 1.0:2007, with Canadian deviations).
 - .2 CSA C61869-2-[14(R2019)], Instrument Transformers - Part 2: Additional Requirements for Current Transformers (Adopted IEC 61869-2:2012, Edition 1.0:2012, with Canadian deviations).
 - .3 CSA C61869-3-[14(R2019)], Instrument Transformers - Part 3: Additional Requirements for Inductive Voltage Transformers (Adopted IEC 61869-3:2011, Edition 1.0:2011, with Canadian deviations).
 - .4 CSA C61869-4-[14(R2019)], Instrument Transformers - Part 4: Additional Requirements for Combined Transformers (Adopted IEC 61869-4:2013, Edition 1.0:2013, with Canadian deviations).

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports.

2. Products

2.01 REVENUE GRADE

- .1 Potential transformers and current transformers for applications of revenue metering to be 0.2% accuracy class.

2.02 POTENTIAL TRANSFORMERS

- .1 Dry type for indoor-use suiting intended applications and with following features:
 - .1 In accordance with CSA C61869-1, CSA C61869-3 and CSA C61869-4.
 - .2 Copper wound coils with high dielectric strength insulation.
 - .3 Encased in thermoplastic case with core and windings encapsulated in resin.
 - .4 Nominal Voltage Class: 600 V, unless otherwise noted, and suiting specific applications.
 - .5 Secondary Voltages: Suiting intended applications.
 - .6 Rated Frequency: 60 Hz.
 - .7 Basic Impulse Level: 600 Volt, 10 kV BIL full wave.

- .8 Voltage Ratio: Suiting intended applications.
- .9 Accuracy Rating: $\pm 1\%$.
- .10 Screw type terminals with lock washers, flat washers and terminal covers.
- .11 Potential transformers fusing as follows to suit specific applications:
 - .1 Fused with separate fuse block.
 - .2 Equipped with fuse holder and fuses.
 - .3 Fuses as noted.

2.03 CURRENT TRANSFORMERS

- .1 Dry type for indoor-use suiting intended applications with following features:
 - .1 In accordance with CSA C61869-1 and CSA C61869-2.
 - .2 Copper windings and grain-oriented silicon core steel.
 - .3 Nominal Voltage Class: 600 V and as noted.
 - .4 Window Size: Suiting intended applications.
 - .5 Rated Frequency: Range from 50 Hz to 400 Hz, 60 Hz typical.
 - .6 Basic Impulse Level: 600 Volts, 10 kV BIL. full wave.
 - .7 Metering and Relay Accuracy Rating: $\pm 1\%$.
 - .8 Rated Primary and Secondary Current: Suiting intended applications.
 - .9 Positive action automatic short-circuiting device in secondary terminals.
 - .10 Brass stud terminals with flat washer, lock washer, and regular nut.
 - .11 Flexible leads 105°C, CSA certified, no.16 AWG, 600 mm long.

2.04 MOUNTING BRACKETS

- .1 Potential transformers with mounting provisions, suiting intended applications including:
 - .1 Suspension hooks for cross arm mounting.
 - .2 Channel type mounting brackets.
 - .3 L type mounting brackets.
- .2 Current transformers mounting kits, suiting intended applications.
- .3 Fabricate brackets and channels from electrogalvanized code gauge painted steel.

3. Execution

3.01 INSTALLATION

- .1 Provide type and ratings of transformers suiting intended applications, packaged with equipment and as ancillary devices supporting installation of other products.
- .2 Install instrument transformers in accordance with manufacturer recommendations. Install in location providing accessibility for maintenance and replacement.
- .3 Review requirements with respective equipment manufacturers and systems to which transformers are installed.

3.02 FIELD QUALITY CONTROL

- .1 Inspection, Testing and Verification:

- .1 Inspect, test and verify products.
- .2 Check connections and operations.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI):
 - .1 ANSI C12.20-[2015], Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes.
 - .2 ANSI C37.50-[2018], Switchgear - Low Voltage AC Power Circuit Breakers Used In Enclosures -Test Procedures.
 - .3 ANSI Z535.1-[2022], American National Standard for Safety Colors.
- .2 CSA Group (CSA):
 - .1 CSA C22.2 No. 5-[16(R2021)], Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures (Tri-national standard with UL 489 and NMX-J-266-ANCE-2016).
 - .2 CSA C22.2 No. 31-[18], Switchgear Assemblies.
 - .3 CSA C22.2 No. 244-[19], Switchboards (Trinational standard with UL 891 and NMX-J-118/2-ANCE).
 - .4 CSA C61869-2-[14(R2019)], Instrument transformers - Part 2: Additional requirements for current transformers (Adopted IEC 61869-2:2012, edition 1.0:2012, with Canadian deviations).
- .3 International Electrotechnical Commission (IEC):
 - .1 IEC 62271-200-[2021], High-Voltage Switchgear and Controlgear - Part 200: AC Metal-Enclosed Switchgear and Controlgear for Rated Voltages Above 1 kV and Up to and Including 52 kV.
- .4 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE C37.13-[2015], IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
 - .2 IEEE C37.16-[2009], IEEE Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers.
 - .3 IEEE C37.17-[2022], IEEE Standard for Trip Systems for Low-Voltage (1000 V and below) AC and General Purpose (1500 V and below) DC Power Circuit Breakers.
 - .4 IEEE C37.20.1-[2015], IEEE Standard for Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
 - .5 IEEE C37.20.7-[2017/Cor 1-2021], IEEE Guide For Testing Switchgear Rated Up To 52 KV For Internal Arcing Faults--Corrigendum 1.
- .5 Underwriters Laboratories (UL):
 - .1 ANSI/UL 489-[Edition 13, 2017], Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
 - .2 ANSI/UL 891-[Edition 12, 2019], Standard for Switchboards.
 - .3 ANSI/UL 1066-[Edition 5, 2022], Power Circuit Breakers up to 1000 V AC and 1500 V DC Used in Enclosures.
 - .4 ANSI/UL 1558-[Edition 5, 2016], Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Submit copies of CSA and UL compliance certificates.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Switchgear: Submit compliance certificates from manufacturer identifying that switchgear is certified and in accordance with ANSI/UL 1558 and CSA C22.2 No. 31.
 - .3 Indicate on Drawings:
 - .1 Ratings.
 - .2 Floor anchoring method and foundation template.
 - .3 Dimensioned cable or bus duct entry and exit locations.
 - .4 Dimensioned position and size of bus.
 - .5 Overall length, height and depth of complete switchgear/switchboard.
 - .6 Dimensioned layout of internal and front panel mounted components.
 - .7 Breakers.
- .3 Submit certified factory inspection and test reports.
- .4 Submit testing and verification reports.

2. Products

2.01 LOW VOLTAGE SWITCHGEAR

- .1 General Features:
 - .1 Indoor, metal enclosed units, CSA certified and ULC listed and labeled.
 - .2 Bussing, structure and power circuit breakers (also referred to as air circuit breakers (ACB) are rated for 30 cycle withstand rating.
 - .3 Suitable for use with building ground system and with minimum short circuit current rating (S.C.C.R.) as noted, but in absence of direction, suiting intended application to local electrical code requirements and with short circuit current rating that is at least equal to or exceeds the available short circuit current at that point of distribution.
 - .4 In accordance with electrical utility standards and regulations for incoming electrical services, where required.
 - .5 Designed, manufactured and tested in accordance with:
 - .1 CSA C22.2 No. 31.
 - .2 IEEE C37.20.1.
 - .3 ANSI/UL 1558.
 - .4 IEEE C37.20.7.

- .6 Clearly labeled on manufacturer identification nameplate as being certified by CSA to applicable standards of Canada.
- .2 Include with shop drawings, copies of certificates verifying switchgear is in accordance with CSA C22.2 No. 31 and ANSI/UL 1558.
- .3 Power circuit breakers or ACBs designed, manufactured and tested in accordance with:
 - .1 IEEE C37.13, IEEE C37.16 and IEEE C37.17.
 - .2 ANSI/UL 1066.
- .4 Switchgear Structure:
 - .1 Consists of individual vertical sections bolted together forming enclosed, self-contained, self-supporting structure on channel type base, and with necessary facilities for proper ventilation.
 - .2 Sections welded or bolted construction, fabricated from sheet steel in accordance with NEMA and CSA requirements. Sections align front and rear.
 - .3 Front doors formed type, fabricated with cold rolled sheet steel and with handle lock operators and locking tabs.
 - .4 Rear access provided with rear doors of hinged type with thumb screw hardware.
 - .5 Grounded vented metal barriers isolate main bus and connections from cable compartment. Vertical barriers provided between cable sections. Full depth section barriers isolate one section from adjacent sections. Barriers isolate incoming line side connections to main breakers from load side bus and connections in switchgear section.
 - .6 Ventilators located on top of switchgear over breaker and bus compartments provide adequate ventilation within enclosure.
 - .7 Each vertical steel section forming part of switchgear is self-contained housing having one or more individual breaker or instrument compartments, centralized bus compartment and rear cable compartment.
 - .8 Each individual circuit breaker compartment or cell is segregated from adjacent compartments and sections by means of steel barriers to maximum extent possible. Each compartment or cell is equipped with drawout rails and primary and secondary disconnecting contacts.
 - .9 Insulating flash shield mounted above each circuit breaker preventing flashover from arc chutes to ground.
 - .10 Safety shutter in cells when circuit breakers withdrawn, which automatically covers line and load stabs and protects against incidental contact. Pad-lockable breaker door prevents access to shutter when breaker is removed from cell.
 - .11 Entire enclosure in accordance with minimum NEMA 2 requirements, and with additional sprinkler protection requirements. Top of each cell complete with drip shield for shedding water without dripping on cell. Enclosure prevents penetration of water spray from activated sprinklers onto live components. Doors and component openings are gasketed and conduit entries sealed watertight.
 - .12 Enclosure finished in manufacturer standard ANSI grey enamel, unless otherwise noted.
- .5 Arc-Resistant Switchgear Additional Requirements:
 - .1 Switchgear labeled identifying that assembly has been assembled and tested according to IEEE C.37.20.7

- .2 Arc rating of switchgear is Type 2B in accordance with IEEE C37.20.7. such that operator is protected around entire perimeter of equipment with low voltage control, instrumentation and breaker secondary customer termination compartment doors open.
- .3 Top of enclosures include arc ventilation that allows exhaust of arc gases during arcing event.
- .4 Arc ventilation system provided within each breaker cell redirecting arc energy to top of enclosure away from operating personnel.
- .5 Arc Plenums:
 - .1 Includes arc plenum tested in accordance with IEEE C.37.20.7 and equipped with external connections to arc duct.
 - .2 Where installed in locations with 3 m minimum floor-to-ceiling height for arc exhaust, with no obstructions in space above switchgear, arc plenum not required.
- .6 Door bellows system installed around front of each breaker prevents arc gasses from escaping around breaker escutcheon, while also allowing easy racking of breaker into disconnected position with door closed.
- .7 Breaker secondary disconnecting devices consist of floating terminals mounted on stationary unit and engaging mating contacts at front of breaker. Breaker secondary disconnecting devices maintained in connected and test positions. Customer access to secondary terminations provided in separate compartment from breaker cell and compartment rated Type 2B in accordance with IEEE C37.20.7.
- .8 Trip Unit Arc-Flash Reduction Maintenance Systems:
 - .1 Trip units include arc-flash reduction maintenance system for reducing trip unit instantaneous pickup value when activated.
 - .2 System does not compromise breaker phase protection even when enabled.
 - .3 When system disabled, recalibration of trip unit phase protection is not required. Activation and deactivation of system setting accomplished without opening circuit breaker door and exposing operators to energized parts.
 - .4 System clearing time of 0.04 seconds, adjustable with minimum of five settings ranging from 2.5X to 10X of sensor value.
 - .5 System includes:
 - .1 System enabling switch on trip unit with confirmation of protection via LED indication.
 - .2 Remote "enable/disable" control.
 - .3 Switchgear panel mounted enable padlockable selector switch and indication via LED pilot light.
 - .6 System wired locally with interposing relays and wired to terminal blocks to enable remote selector switch and confirmation light to be mounted at downstream protected distribution equipment.
- .6 Future Cells:
 - .1 Bus terminations for future extensions and gasketed water-tight removable side panels accommodating installation and connection of future cells.

- .2 Where future draw-out power circuit breakers are indicated, bus, stationary element, CT's, control and metering wiring, provided such that, only draw-out element is needed.
- .3 Drill and plate main bus and switchgear for provision for future extension of additional vertical cell sections at each end of switchgear.
- .7 Bus Bars:
 - .1 Main Bus Bars:
 - .1 Constructed of 98% pure, rectangular copper bars, silver plated at joints with lap type joints bolted using high strength steel bolts and extra wide, extra thick washers providing maximum pressure and even current distribution at each joint.
 - .2 Bus and connections designed for maximum temperature rise in any part of switchgear not to exceed 65 C° over ambient temperature of 40°C.
 - .3 Bus properly isolated and designed to carry currents suiting intended applications.
 - .2 Ground Bus:
 - .1 Continuous ground bus not less than 6 mm x 50 mm cross section area extending length of switchgear.
 - .2 Solidly bolted to steel framework.
 - .3 Constructed of same material as main bus and with suitable lugs for grounding connections.
 - .4 Short-time withstand rating matches that of largest circuit breaker within assembly.
 - .3 Supplied with bolts, nuts, and washers for field connection of bus joints between cells. Hardware of high-tensile strength and zinc-plated with use of Belleville-type washers on bus joints.
- .8 Control Wiring:
 - .1 Each cell provided with control wiring and terminal blocks.
 - .2 Control Wiring: Type "SIS", minimum size No. 14, extra flexible wire with thermoplastic insulation. Neatly harness and suitably secure control wiring.
 - .3 Terminal Blocks: Pressure type, with removable marking strips.
 - .4 Shorting Blocks: Enclosed barrier type within control cubicle.
- .9 Switchgear Arrangement and Components:
 - .1 Switchgear cell arrangements and components: As detailed on drawings.
 - .2 Main bussing not run lower than 300 mm above finished floor level.
 - .3 80% rated breakers unless otherwise noted.
- .10 Main Breakers, Tie Breakers and Distribution Breakers:
 - .1 Power Air Circuit Breakers:
 - .1 Refer to drawings or schedules for types and ratings.
 - .2 UL listed for application of 80% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.
 - .3 Refer to requirements specified in Section 26 28 17 - Low Voltage Breakers.
- .11 Metering System:

- .1 Microprocessor-based monitoring and digital metering system with features as follows:
 - .1 Provides electrical metering with waveform display and embedded WEB server, and system voltage protection.
 - .2 In accordance with ANSI C12.20 Class 0.2%.
 - .3 Measures and displays: Voltage, current, frequency and time, and calculates and displays kW, KWh, KW demand, ampere demand, kVA, kVA demand, kVAR, kVARh, peak ampere demand, peak kVA demand and individual current and voltage harmonics.
 - .4 Configurable event triggers for out of limit settings and demand overload settings. Triggers initiate actions of performance monitoring, waveform capture, parameter capture, sending e-mail message and alarm output.
 - .5 Adjustable protective alarm features: Voltage phase loss, current phase loss, line voltage phase loss, voltage phase reversal, over voltage, under voltage and time delay.
 - .6 Graphical backlit LCD/LED display.
 - .7 Inputs/outputs, contacts, RS485/RS232/MODBUS/TCP/IP Ethernet/BAC Net interfaces for compatible communications to remote monitoring terminal, printer and BAS.
 - .8 Current transformers, potential transformers and control wiring.
 - .9 Custom clear impact-resistant acrylic, hinged and locking cover over each unit.
 - .2 Provide each power circuit breaker with functionality and features of metering system.
- .12 Metering System:
- .1 Microprocessor-based monitoring and digital metering system with features as follows:
 - .1 Provides electrical metering and system voltage protection.
 - .2 Measures and Displays: Voltage, current, frequency and time, and calculates and displays KW, KWh, KW demand, ampere demand, KVA, KVA demand, KVAR and KVARh.
 - .3 Adjustable protective alarm features: Voltage phase loss, current phase loss, line voltage phase loss, voltage phase reversal, over voltage, under voltage and time delay.
 - .4 LED six-digit display screen.
 - .5 Inputs/outputs, contacts, RS485/RS232/MODBUS/TCP/IP Ethernet/BACnet interface for compatible communications to remote monitoring terminal, remote printer and BAS.
 - .6 Current transformers, potential transformers and control wiring.
 - .7 Custom clear impact-resistant acrylic, hinged and locking cover over each unit.
 - .2 Provide each power circuit breaker with functionality and features of metering system.
- .13 Utility Metering Provisions:
- .1 Review with and coordinate utility metering requirements with electrical utility. Provide products in accordance with electrical utility standards including ANSI level of accuracy.

- .2 Metering cells for utility metering and current transformers (CTs) and potential transformers (PTs) and associated fuses: In accordance with utility requirements and suiting intended applications.
- .3 Provide minimum 38 mm diameter conduit stub in bottom of each metering cell for site extension of conduit to meters.
- .14 Current and Potential Transformers:
 - .1 In accordance with CSA C61869-2 and Section 26 22 19 - Control and Signal Transformers.
 - .2 Dry type, indoor with ratings, suiting intended applications.
 - .3 Potential transformers are of compartment type and incorporate current limiting fuses.
 - .4 Current transformers have ratios suiting intended applications, mechanical rating equal to momentary rating of circuit breakers, and insulated for full voltage rating of switchgear.
 - .5 CTs and PTs for local electrical utility metering are typically supplied by local electrical utility. Where CTs and PTs are not supplied by electrical utility, provide in accordance with utility requirements and suiting intended applications.
 - .6 Electrogalvanized code gauge painted steel mounting brackets and channels to secure transformers in place.
 - .7 Ship CTs and PTs to switchgear manufacturer factory for factory mounting and connection into metering cells, and secondary connected to terminal blocks.
- .15 Mechanical Key Interlock:
 - .1 Mechanical key interlock systems connected to main breakers and tie breakers of switchgear are as noted, providing sequence of operations as noted. Typically, system is three lock, two key arrangements, permitting any two of three locks closed at a time. Prior to ordering, review requirements with Consultant.
 - .2 Refer to Section 26 18 41 - Interlock Systems, for additional requirements.
- .16 Incoming and Outgoing Conductor Connection Facilities:
 - .1 Provide facilities and hardware for cable in conduit and bus duct, as noted and suiting intended applications.
- .17 Surge Protective Devices (SPD):
 - .1 Integral SPD unit, factory installed in dedicated cell and connected onto bussing through integral breaker of type and size in accordance with manufacturer recommendations.
 - .2 Unit includes diagnostic package with status indicators on each phase, LCD surge counter display, audible alarm with silence button and Form C alarm contacts.
 - .3 Unit maintenance-free.
 - .4 Refer to Section 26 43 00 - Surge Protection Devices, for additional SPD requirements for switchgear.
- .18 Thermographic Scanning Windows:
 - .1 Locate thermographic scanning windows in locations allowing for infrared survey cameras to scan live components, breakers and switches and their connections, cable connection and bussing, without opening of doors and panels.
 - .2 Infrared inspection windows with features as follows:

- .1 CSA certified, or ULC listed and labeled, and in accordance with IEC 62271-200.
 - .2 Rated for respective switchgear.
 - .3 Locking ring with teeth to lock tight to inside of panel that automatically grounds metal components and requires no screw holes.
 - .4 Quick access hinged cover with thumb screw release of permanently hinged IR window cover with inside label for permanent identification.
 - .5 Broadband crystal IR window lens encased in anodized aluminum frame suitable for indoor (NEMA 12) and outdoor (NEMA 4) scans.
 - .6 Transmits short, mid and longwave IR images.
 - .7 Supports visual inspections and fusion features.
 - .8 Allows laser pointers and illumination to shine through.
 - .9 Maximum operating temperature 260°C.
 - .10 Round sizes from 50 mm to 100 mm diameters.
- .19 Mimic Bus, Nameplates and Signage:
- .1 Mimic Bus: Red, single line vinyl bus approximately 3 mm thick x 9 mm wide representing internal bussing and components rivetted to front of switchgear and extending through handles of respective breakers and switches.
 - .2 Nameplates: Engraved lamicoid nameplates secured with stainless steel screws, adjacent each panel component and identifying each component.
 - .3 Warning signage and labels: Affixed on face of compartment doors allowing access to live components.
 - .4 Label internally mounted devices with designation matching drawings.
 - .5 Label door mounted components, conveying their function to operations personnel.
 - .6 Equipment Rating Identification Nameplates: Identifying certifications, approvals and standards of compliance.
 - .7 Prior to manufacturing, submit proposed nameplate and signage nomenclature, finishes colours, and sizing to Consultant for review. Nomenclatures as noted, are for reference only. Provide temporary identification labels during testing.
- .20 Accessories:
- .1 Manufacturer standard accessories, spare parts and maintenance tool kit.
 - .2 Breaker lift truck (for draw-out breakers). Rail mounted on top of switchgear for access to multiple power circuit breakers.
 - .3 Wall-mounting spare fuse rack.
 - .4 Manufacturer installation drawings.
 - .5 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and switchgear manufacturer recommendations.
 - .6 Rubber insulating mats: Minimum 900 mm wide x 9 mm thick and length of switchgear, for front and where accessible, rear of switchgear.

2.02 LOW VOLTAGE SWITCHBOARDS

- .1 General Features:
- .1 Indoor, metal enclosed units, CSA certified, and ULC listed and labeled.

- .2 Suitable for use with building ground system and with minimum short circuit current rating (S.C.C.R.) as noted, but in absence of direction, suiting intended application to local electrical code requirements and with short circuit current rating that is at least equal to or exceeds the available short circuit current at that point of distribution.
 - .3 Where required, in accordance with electrical utility standards and regulations for incoming electrical services.
 - .4 Designed, manufactured and tested in accordance with:
 - .1 CSA C22.2 No. 31.
 - .2 CSA C22.2 No. 244.
 - .3 ANSI/UL 891.
 - .5 Clearly labelled on manufacturer identification nameplate as being certified by CSA to applicable standards of Canada.
- .2 Power air circuit breakers (ACBs) designed, manufactured and tested in accordance with:
- .1 ANSI C37.50.
 - .2 IEEE C37.13.
 - .3 IEEE C37.16.
 - .4 ANSI/UL 1066.
- .3 Insulated case and moulded case breakers designed, manufactured and tested in accordance with:
- .1 CSA C22.2 No. 5.
 - .2 ANSI/UL 489.
- .4 Switchboard Structure:
- .1 Consists of individual sections bolted together forming enclosed, self-contained, self-supporting structure on channel type base, and with necessary facilities for proper ventilation.
 - .2 Sections welded or bolted construction, fabricated from sheet steel in accordance with NEMA and CSA requirements. Sections align front and rear.
 - .3 Front doors formed type, fabricated with cold rolled sheet steel and with handle lock operators and locking tabs.
 - .4 Rear, top and side panels are bolt-on, unless otherwise noted.
 - .5 Entire enclosure in accordance with minimum NEMA 2 requirements, and with additional sprinkler protection requirements. Top of each cell complete with drip shield for shedding water without dripping on cell. Enclosure prevents penetration of water spray from activated sprinklers onto live components. Doors and component openings are gasketed and conduit entries sealed watertight.
 - .6 Enclosure finished in manufacturer standard ANSI grey enamel, as reviewed with Consultant.
- .5 Future Cells:
- .1 Bus terminations for future extensions and gasketed water-tight removable side panels accommodating installation and connection of future cells.
 - .2 Where future draw-out power circuit breakers are indicated, bus, stationary element, CTs, control and metering wiring, provided such that, only draw-out element is needed.

- .3 Drill and plate main bus and switchboard for provision for future extension of additional vertical cell sections at each end of switchboard.
- .6 Bus Bars:
 - .1 Main Bus Bars:
 - .1 Constructed of 98% pure, rectangular copper bars, silver plated at joints with lap type joints bolted using high strength steel bolts and extra wide, extra thick washers providing maximum pressure and even current distribution at each joint.
 - .2 Bus and connections designed for maximum temperature rise in any part of switchboard not to exceed 65 C° over ambient temperature of 40°C.
 - .3 Bus properly isolated and designed to carry currents suiting intended applications.
 - .2 Ground Bus:
 - .1 Continuous ground bus not less than 6 mm x 50 mm cross-section area extending length of switchboard.
 - .2 Solidly bolted to steel framework.
 - .3 Constructed of same material as main bus and with suitable lugs for grounding connections.
 - .4 Rated for momentary current rating equal to or greater than that of apparatus in switchboard.
 - .3 Supplied with required bolts, nuts, and washers for field connection of bus joints between cells.
- .7 Control Wiring:
 - .1 Each cell provided with control wiring and terminal blocks.
 - .2 Control Wiring: Type SIS, minimum size No. 14, extra flexible wire with thermoplastic insulation. Neatly harness and suitably secure control wiring.
 - .3 Terminal Blocks: Pressure type, with removable marking strips.
 - .4 Shorting Blocks: Enclosed barrier type within control cubicle.
- .8 Switchboard Arrangement and Components:
 - .1 Switchboard cell arrangements and components: As detailed on drawings.
 - .2 Main bussing not run lower than 300 mm above finished floor level.
 - .3 Provide 80% rated breakers as noted.
- .9 Main Breakers and Tie Breakers:
 - .1 Refer to drawings or schedules for types and ratings.
 - .2 Power Air Circuit Breakers:
 - .1 ULC listed for application of 80% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.
 - .2 Refer to requirements specified in Section 26 28 17 - Low Voltage Breakers.
 - .3 Insulated Types:
 - .1 As noted and as required for application, fixed mounted, solid state insulated case circuit breaker with adjustable trip unit. Provide minimum interrupting capacity as scheduled.
 - .2 Where noted, ULC listed for application of 80% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.

- .3 Refer to requirements specified in Section 26 28 17 - Low Voltage Breakers.
- .4 Moulded Case Types:
 - .1 As noted and as required for application, fixed mounted, solid state moulded case circuit breaker with adjustable trip unit. Provide minimum interrupting capacity as scheduled.
 - .2 Where noted, ULC listed for application of 80% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.
 - .3 Refer to requirements specified in Section 26 28 17 - Low Voltage Breakers.
- .10 Metering System:
 - .1 Based monitoring and digital metering system with features as follows:
 - .1 Provides electrical metering and system voltage protection.
 - .2 Measures and displays: Voltage, current, frequency and time, and calculates and displays KW, KWh, KW demand, ampere demand, KVA, KVA demand, KVAR and KVARh.
 - .3 Adjustable Protective Alarm Features: Voltage phase loss, current phase loss, line voltage phase loss, voltage phase reversal, over voltage, under voltage and time delay.
 - .4 LED six-digit display screen.
 - .5 Inputs/outputs, contacts, RS485/RS232/MODBUS/TCP/IP Ethernet interface for compatible communications to remote monitoring terminal, remote printer and BAS.
 - .6 Current transformers, potential transformers and control wiring.
 - .7 Custom clear impact-resistant acrylic, hinged and locking cover over each unit.
 - .2 Provide each power circuit breaker with functionality and features of metering system.
- .11 Utility Metering Provisions:
 - .1 Review with and coordinate with electrical utility, utility metering requirements and provide as required by electrical utility. Provide products in accordance with electrical utility standards including ANSI level of accuracy. Prior to ordering, review requirements with Consultant.
 - .2 Provide metering cells for utility metering and current and potential transformers and associated fuses in accordance with utility requirements and intended applications.
 - .3 Provide minimum 38 mm diameter conduit stub in bottom of each metering cell for site extension of conduit to meters.
- .12 Current and Potential Transformers:
 - .1 In accordance with CSA C61869-2 and Section 26 22 19 - Control and Signal Transformers.
 - .2 Dry type, indoor with ratings, suiting intended applications.
 - .3 Potential transformers (PTs) are of compartment type and incorporate current limiting fuses.

- .4 Current transformers (CTs) have ratios suiting intended applications, mechanical rating equal to momentary rating of circuit breakers, and insulated for full voltage rating of switchboard.
- .5 CTs and PTs for local electrical utility metering are typically supplied by local electrical utility. Where CTs and PTs are not supplied by electrical utility, provide in accordance with utility requirements and suiting intended applications.
- .6 Electrogalvanized code gauge painted steel mounting brackets and channels to secure transformers in place.
- .7 Ship CTs and PTs to switchgear manufacturer factory for factory mounting and connection into metering cells, and secondary connected to terminal blocks.
- .13 **Circuit Breakers Distribution Section:**
 - .1 Types and ratings: As noted.
 - .2 Electrically operated drawout or fixed-mounted power circuit breakers: As specified for main breakers and as noted.
 - .3 Circuit breaker distribution section: Consisting of insulated case, bolt-on circuit breakers with interrupting capacity as noted and frame size suiting intended applications.
 - .4 Circuit breaker distribution section: Consisting of moulded case, bolt on circuit breakers with interrupting capacity as noted and frame size suiting intended applications.
 - .5 Breakers of frame size greater than 225 A: Provided with solid state adjustable trip units.
 - .6 For moulded case type distribution section, include full size hinged locking door over section.
 - .7 Refer to requirements specified in Section 26 28 17 - Low Voltage Breakers.
- .14 **Switch and Fuse Distribution Section:**
 - .1 Types and ratings: As noted.
 - .2 Quick-make, quick-break, visible contact load break switches with operating handles and facilities for locking in either ON or OFF position.
 - .3 HRC Form I, Class J current limiting fuses, unless otherwise noted.
- .15 **Surge Protective Devices (SPD):**
 - .1 Integral SPD unit, factory installed in dedicated cell and connected onto bussing through integral breaker of type and size in accordance with manufacturer recommendations.
 - .2 Unit includes diagnostic package with status indicators on each phase, LCD surge counter display, audible alarm with silence button and Form C alarm contacts.
 - .3 Unit maintenance-free.
 - .4 Refer to Section 26 43 00 - Surge Protection Devices, for additional SPD requirements for switchgear.
- .16 **Thermographic Scanning Windows:**
 - .1 Locate thermographic scanning windows in locations allowing for infrared survey cameras to scan live components, breakers and switches and their connections, cable connection and bussing, without opening of doors and panels.
 - .2 Infrared inspection windows with features as follows:

- .1 CSA certified, or ULC listed and labeled, and in accordance with IEC 62271-200.
 - .2 Rated for respective switchgear.
 - .3 Locking ring with teeth to lock tight to inside of panel that automatically grounds metal components and requires no screw holes.
 - .4 Quick access hinged cover with thumb screw release of permanently hinged IR window cover with inside label for permanent identification.
 - .5 Broadband crystal IR window lens encased in anodized aluminum frame suitable for indoor (NEMA 12) and outdoor (NEMA 4) scans.
 - .6 Transmits short, mid and longwave IR images.
 - .7 Supports visual inspections and fusion features.
 - .8 Allows laser pointers and illumination to shine through.
 - .9 Maximum operating temperature 260°C.
 - .10 Round sizes from 50 mm to 100 mm diameters.
- .17 Mimic Bus, Nameplates and Signage:
- .1 Mimic Bus: Red, single line vinyl bus approximately 3 mm thick x 9 mm wide representing internal bussing and components rivetted to front of switchboard and extending through handles of respective breakers and switches.
 - .2 Nameplates: Engraved lamicoid nameplates secured with stainless steel screws, adjacent each panel component and identifying each component.
 - .3 Warning signage and labels: Affixed on face of compartment doors allowing access to live components.
 - .4 Label internally mounted devices with designation matching drawings.
 - .5 Label door-mounted components, conveying their function to operations personnel.
 - .6 Equipment Rating Identification Nameplates: Identifying certifications, approvals and standards of compliance.
 - .7 Prior to manufacturing, submit proposed nameplate and signage nomenclature, finishes colours, and sizing to Consultant for review. Nomenclatures as noted, are for reference only. Provide temporary identification labels during testing.
 - .8 Approvals: As required by AHJ.
- .18 Accessories:
- .1 Manufacturer standard accessories, spare parts and maintenance tool kit.
 - .2 Breaker lift truck (for draw-out breakers). Rail-mounted on top of switchboard for access to multiple power circuit breakers.
 - .3 Wall-mounting spare fuse rack.
 - .4 Manufacturer installation drawings.
 - .5 Neutral grounding resistors (NGR): Refer to requirements of Section 26 05 27 - High Resistance Grounding.
 - .6 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and switchboard manufacturer recommendations.
 - .7 Rubber Insulating Mats: Minimum 900 mm wide x 9 mm thick and length of substation, for front and where accessible, rear of switchboard.

2.03

EMERGENCY GENSET SWITCHBOARDS/SWITCHGEAR

- .1 Emergency genset switchboards/switchgear based on:
 - .1 LV switchboard to ANSI/UL 891 and CSA standards as specified.
 - .2 LV switchgear to ANSI/UL 1558 and CSA standards as specified.
- .2 Switchgear/switchboard include synchronization and paralleling controller, controls, components and software.
- .3 Refer to Section 26 32 14 – Natural Gas Electric Generating Units for additional requirements.

2.04 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Switchgear and Switchboards:
 - .1 Eaton.
 - .2 Schneider.
 - .3 Siemens.

3. Execution

3.01 INSTALLATION OF SWITCHGEAR AND SWITCHBOARDS

- .1 Arrange for equipment manufacturer to provide necessary drawings for assembly and installation of equipment. Obtain from manufacturer, copies of installation, detail and assembly drawings required for approval of installation from AHJ. Obtain compliance certificates.
- .2 Install switchgear and switchboards into positions. Base layout, design, connections and requirements for supplied accessories from documents and reviewed shop drawings. Examine drawings and site conditions, verifying that equipment can be positioned into their designated positions, without difficulty. Install with access clearance for operation and maintenance.
- .3 Assemble individual sections of equipment in accordance with manufacturer recommendations and instructions, and secure assembly to concrete base. Torque bus joint bolts in accordance with manufacturer recommendations. Arrange equipment in configuration as indicated on drawings and reviewed shop drawings.
- .4 Provide seismic restraints as noted.
- .5 Make incoming and outgoing power cable connections to equipment in accordance with equipment and cable manufacturer recommendations. Make connections and terminations and provide bus flanges suitable for specific incoming and outgoing cables and bus ducts.
- .6 Coordinate cable, bus duct and conduit (as applicable and as noted) entry location to match incoming cable and bus duct. Allow sufficient space for required cable bending radii and connections. Where bus duct is used for connections, coordinate orientation to match and provide appropriate bus duct connection flanges.
- .7 Do not penetrate enclosure tops or drip shields unless reviewed with and recommended for acceptance by Consultant. Where Consultant makes such recommendation, provide raintight fittings for armoured cable and conduit entries into switchgear and switchboards, and make water-tight seal penetrations through drip shields and equipment enclosure openings.
- .8 Coordinate delivery and installation of electrical utility supplied metering transformers.

- .9 Install controls and displays at height of between minimum 1200 mm to maximum of 1800 mm above finished floor level.
- .10 Provide breakers and switches. Set-up and adjust breaker trip settings as determined by results of distribution system coordination studies specified in Section 26 05 73 - Power System Studies, and reviewed with Consultant.
- .11 Provide alarm and communications circuits. Integrate equipment to BAS. Extend wiring in conduit to interconnection terminal cabinet. Provide wiring in conduit from cabinet to respective BAS panel serving area. Make connections. Coordinate requirements with respective equipment vendors. Integration points to BAS include:
 - .1 Switchgear or switchboard loss of power.
 - .2 Switchgear or switchboard ground fault.
 - .3 Metering data.
 - .4 SPD fault.
 - .5 PFC fault.
 - .6 Neutral grounding resistor fault.
- .12 Ground and bond equipment to ground electrode grids.
- .13 Install, connect and test SPD with connected breaker, in accordance with manufacturer instructions.
- .14 Subject to electrical utility requirements, provide following:
 - .1 Prior to submittal of shop drawings to Consultant, submit switchgear/switchboard shop drawings to electrical utility for approval.
 - .2 Prior to energization, arrange for electrical utility inspection and approval of completed equipment installation. Arrange and coordinate primary cable connections and metering requirements with electrical utility.
 - .3 Extend minimum 38 mm diameter conduit from each metering cell to meter backboard for meter connection wiring. Confirm metering requirements with electrical utility and with Consultant.
 - .4 Utility compliance certificates. Submit with testing and verification reports.

3.02 IDENTIFICATION

- .1 Provide product with engraved lamicaid nameplates.
- .2 Equipment Main Nameplates: Size 4 unless otherwise noted and engraved as noted.
- .3 Nameplate for Each Circuit Breaker: Size 2 unless otherwise noted and engraved as noted.
- .4 Identify breakers feeding essential services with nameplates of dedicated colour, reviewed with Consultant.

3.03 FIELD QUALITY CONTROL

- .1 Manufacturer technician to:
 - .1 Perform standard factory testing and submit copy of detailed reports to Consultant for review.
 - .2 Assist in onsite installation of equipment, and to onsite inspect installation, test equipment, perform start-up and verify equipment.

- .3 Assist in integration of equipment to other building systems and equipment (such as BAS, Gensets/ UPS/ATS/Central monitoring system).
- .4 Perform after installation final tuning of power factor system when building is in normal operations.
- .5 Be present to assist during third-party testing in accordance with Section 26 05 70 - Electrical Testing.
- .2 Inspection, Start-up, Testing and Verification:
 - .1 Inspect, start-up, test and verify products.
 - .2 Check connections and operations.
 - .3 Test key-operator locks and sequence of operation.
 - .4 Test SPD with connected breaker.
 - .5 Test and adjust controls and safeties.
 - .6 Test remote alarms and remote communications to other building systems.
 - .7 Verify equipment operations are in accordance with Specifications and manufacturer requirements.
- .3 Prepare testing and verification reports signed by testing technician. Submit reports and compliance certificates to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards (ANSI):
 - .1 ANSI Z535.1-[2022], American National Standard for Safety Colors.
- .2 CSA Group (CSA):
 - .1 CSA C22.2 No. 29-[15(R2019)], Panelboards and Enclosed Panelboards.
 - .2 CSA C22.2 No. 248.4-[00(R2019)], Low-Voltage Fuses - Part 4: Class CC Fuses (Tri-National standard, with UL 248-4 and NMX-J-009/248/4-2000-ANCE).

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Identify:
 - .1 Breakers and ratings.
 - .2 Panelboard dimensions.
 - .3 Lock keying requirements, as applicable.
- .3 Submit testing and verification reports.
- .4 Submit copies of completed and typed breaker circuit directory cards.

2. Products

2.01 GENERAL

- .1 In accordance with reference standards.
- .2 Product of one manufacturer.
- .3 Factory fully assembled and tested. Ship fuses loose for onsite installation.
- .4 CSA approved, or ULC listed and labeled.
- .5 In addition to CSA requirements, provide manufacturer nameplates identifying fault current that panelboards, breakers and fused switches are built to withstand.
- .6 250 V Panelboards: Bus and switch and fuse units rated as noted.
- .7 600 V Panelboards: Bus and switch and fuse units rated as noted.
- .8 Refer to drawings/schedules for:
 - .1 Enclosure configurations and types.
 - .2 Panelboards mains ratings.

- .3 Types of breakers and ratings.
- .4 Bussing ratings.
- .5 Number of circuits, and number and size of breakers.
- .6 Spare breakers.
- .7 Spaces.

2.02 BRANCH CIRCUIT PANELBOARDS – BREAKER TYPE

- .1 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.
- .2 Enclosures constructed of code gauge galvanized steel with removable box ends, wiring gutter space on sides, and dead-front construction to shield user from energized parts. Trim for flush or surface-wall mounting suiting installation as noted.
- .3 Hinged door with concealed fasteners, concealed hinge, chrome-plated door-latch and keyed-alike lock with key. Front panel not removable with door locked. Provide flush locks for each panel board with minimum 2 keys for each panelboard. Key panelboards alike, unless otherwise noted.
- .4 Steel frame holder and typed circuit directory card protected by clear acetate and secured to back of door, and Mylar circuit breaker identification strips.
- .5 Copper Bussing: With neutral of same ampere rating of mains, unless otherwise noted.
- .6 Provide 200% neutrals for panelboards as noted, and with surge protective device connected.
- .7 Mains: Main lug connections or main bolt-on breakers, as noted.
- .8 Isolated ground bus.
- .9 Include grounding busbar with three terminals for bonding conductor equal to breaker capacity of panelboard.
- .10 Filler plates covering unused mounting space.
- .11 Enclosures in Climate-Controlled Areas:
 - .1 Minimum NEMA 1 unless otherwise noted,
 - .2 Ventilation louvres designed to prevent penetration of water spray onto live components.
 - .3 Enclosures, trims and doors factory painted in manufacturer standard ANSI gray baked enamel, unless otherwise noted.
 - .4 Surface mounted:
 - .1 Drip shield with no penetrations.
 - .2 Rain-tight conduit fittings sealing conduit entries watertight.
- .12 Surge Protection Device (SPD):
 - .1 Integral or external to panelboards as noted.
 - .2 Unit installed and connected onto bussing through integral disconnect or breaker as recommended by manufacturer.
 - .3 Unit includes diagnostic package with status indicators on each phase, audible alarm and Form C alarm contacts.
 - .4 Unit is maintenance-free.

- .5 Refer to Section 26 43 00 - Surge Protection Devices for additional requirements.

2.03 DISTRIBUTION PANELBOARDS – BREAKER TYPE

- .1 Panelboard mains, number of circuits, and number and size of branch circuit breakers:
As noted.
- .2 Single or double row as required and with moulded case, bolt-on circuit breakers. Locate both main lugs and neutral bar at same end. Shield main lugs through a removable cover. Identify each circuit breaker adjacent breaker handle.
- .3 Panelboard Interior: Three flat bus bars stacked and aligned vertically with insulators laminated between phases. Insulators support and provide phase isolation to entire length of bus. Solidly bonded equipment ground bar and neutral bar provided.
- .4 Bus Bars (phases, grounds and neutrals): Constructed of hard-drawn electrical grade copper, silver-plated and extending throughout panel.
- .5 Interior Trim: Dead-front construction shielding user from energized parts.
- .6 Main circuit breaker and main lug interiors field convertible for top or bottom incoming feed.
- .7 Panelboard Boxes: Constructed of code gauge, hot zinc-dipped galvanized steel. With removable ends and wiring gutter space on sides in accordance with CSA requirements.
- .8 Floor-Mounted Enclosures: Free-standing type, reinforced providing support strength. Provide seismic restraints specified.
- .9 Enclosures Located in Climate-Controlled Areas:
 - .1 Minimum NEMA 1 unless otherwise noted,
 - .2 Ventilation louvres designed to prevent penetration of water spray onto live components.
 - .3 Factory painted in manufacturer standard ANSI gray baked enamel, unless otherwise noted.
 - .4 Surface mounted:
 - .5 Drip shield with no penetrations.
 - .6 Rain-tight conduit fittings sealing conduit entries watertight.
- .10 Distribution panelboards not located in secured electrical rooms or closets, require doors. Provide doors with latches and keyed-alike locks on panelboards located in unsecure areas. Locks of cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. Supply at least 2 keys with each lock. Key panelboards alike, unless otherwise noted.
- .11 Future Provisions: As noted. Include space provision for breakers, and bussing for full panel size. Where spare breakers are noted, provide breakers. For unused spaces, equip for future devices, with connectors and mounting hardware.
- .12 Mains: Suiting bolt-on breakers.
- .13 Drip shield for surface-mounted panelboards.
- .14 Filler plates covering unused mounting space.
- .15 Surge Protection Device (SPD):
 - .1 Integral or external to panelboards as noted.

- .2 Unit installed and connected onto bussing through integral disconnect or breaker as recommended by manufacturer.
- .3 Unit includes diagnostic package with status indicators on each phase, audible alarm and Form C alarm contacts.
- .4 Unit is maintenance-free.
- .5 Refer to Section 26 43 00 - Surge Protection Devices (SPD) for additional requirements.
- .16 Include grounding busbar with three terminals for bonding conductor equal to breaker capacity of panelboard.

2.04 BREAKERS

- .1 Refer to Section 26 28 17 - Low Voltage Breakers, for additional requirements.
- .2 Breakers with thermal and magnetic tripping in panelboards as noted: Provide inverse time current tripping and instantaneous tripping for short circuit protection.
- .3 Main Breaker: Separately mounted on top or bottom of panel suiting cable entry. When mounted vertically, down position opens breaker.
- .4 Lock-on devices for 10% of 15 to 30 A breakers installed. Turn over unused lock-on devices to Consultant.
- .5 Lock-on Devices for Circuits: As noted.
- .6 Breaker Accessories: As noted.

2.05 DISTRIBUTION PANELBOARDS – SWITCH AND FUSE TYPE

- .1 Panelboard mains, number of circuits, and number and size of switch and fuse units: As noted.
- .2 Single or double row as required and with quick-make, quick-break, visible contact load break switches with operating handles projecting through dead-front panel and interlocked with switch mechanism, facilities for padlocking in either ON or OFF position, and, unless otherwise noted, HRC Form I, Class "J" fuses. Fuses in accordance with CSA C22.2 No. 248.4.
- .3 Panelboard Interior: Three-flat bus bars stacked and aligned vertically with insulators laminated between phases. Insulators support and provide phase isolation to entire length of bus. Solidly bonded equipment ground bar and neutral bar provided.
- .4 Bus Bars (phases, grounds and neutrals): Constructed of hard-drawn electrical grade copper, silver-plated and extend throughout panel.
- .5 Interior Trim: Dead-front construction shielding user from energized parts.
- .6 Panelboard Boxes: Constructed of code gauge, hot zinc-dipped galvanized steel. With removable ends and wiring gutter space on sides in accordance with CSA requirements.
- .7 Floor-Mounted Enclosures: Free-standing type, reinforced providing support strength. Provide seismic restraints specified.
- .8 Enclosures Located in Climate-controlled Areas:
 - .1 Minimum NEMA 1 unless otherwise noted,
 - .2 Ventilation louvres designed to prevent penetration of water spray onto live components.

- .3 Factory painted in manufacturer standard ANSI gray baked enamel, unless otherwise noted.
- .4 Surface Mounted:
 - .1 Drip shield with no penetrations.
 - .2 Rain-tight conduit fittings sealing conduit entries watertight.
- .9 Distribution panelboards sized 600 A and less and panelboards not located in secured electrical rooms or closets, require doors. Provide doors, latches, and keyed-alike locks, on panelboards sized up to 600 A and panelboards located in unsecure areas. Locks of cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. Supply at least 2-keys with each lock.
- .10 Future Provisions: As noted. Include space provision for switches, and bussing for full panel size. Where spare switches are noted, provide switches. For unused spaces, equip for future devices, with connectors and mounting hardware.
- .11 Main Switch: As noted.
- .12 Suitable for bolt-on fusible sections.
- .13 Fusible pull-outs or door-operated type switches not acceptable.
- .14 Fuse Clips: Suitable for type of fuses specified for each unit.
- .15 Fuses: Type suiting specific applications, and size as noted.
- .16 Drip shield for surface mounted panelboards.
- .17 Filler plates covering unused mounting space.
- .18 Surge Protection Device (SPD):
 - .1 Integral or external to panelboards as noted.
 - .2 Unit installed and connected onto bussing through integral disconnect or breaker as recommended by manufacturer.
 - .3 Unit includes diagnostic package with status indicators on each phase, audible alarm and Form C alarm contacts.
 - .4 Unit is maintenance-free.
 - .5 Refer to Section 26 43 00 - Surge Protection Devices (SPD) for additional requirements.
- .19 Include grounding busbar with three-terminals for bonding conductor equal to switch capacity of panelboard.

2.06 SPECIAL PANELBOARD ASSEMBLIES AND ACCESSORIES

- .1 Features: In accordance with specified panelboards but with modifications as noted.
- .2 Column Type: As noted.
- .3 Double Stack Panels: As noted.
- .4 Contactors in Mains: As noted.
- .5 Feed Through Lugs: As noted.
- .6 Lock Keying: Suiting user requirements as confirmed with Consultant.

2.07 CUSTOM IDENTIFICATION PAINTING

- .1 Factory paint panelboards connected to emergency or essential power systems with enamel in dedicated colour finish (typically ANSI Z535.1 standard orange or red), as reviewed with Consultant.

2.08 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Panelboards:
 - .1 Eaton.
 - .2 Schneider.
 - .3 Siemens.

3. Execution

3.01 INSTALLATION OF PANELBOARDS

- .1 Provide panelboards with breakers, switch and fuses, and accessories. Provide lock keying requirements as reviewed with Consultant.
- .2 Locate panelboards and mount securely, plumb, true and square, to adjoining surfaces. Install panelboards with clearance for access for operation and maintenance. Support cabinets and enclosures independent of connecting conduit and install with reference to wall finishes.
- .3 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.
- .4 Install floor-mounted panelboards on concrete housekeeping pads. Provide seismic restraints as noted.
- .5 Equip each panelboard with lugs to accommodate main and branch conductors as scheduled.
- .6 Mount panelboards to height specified in Section 26 05 00 - Common Work Results – Electrical or as noted. Prior to roughing-in, review height with Consultant.
- .7 Connect loads to circuits.
- .8 Connect neutral conductors to common neutral bus.
- .9 Where SPD is required for panelboards, install and test in accordance with SPD manufacturer instructions.
- .10 Ground and bond equipment.
- .11 Set trip unit functions suiting intended applications.
- .12 Seal openings and conduit entries of enclosures and drip shield, watertight.

3.02 INSTALLATION OF FUSES

- .1 Before energizing circuits, install fuses in mounting devices.
- .2 Verify correct fuses fitted to physically matched mounting devices.
- .3 Install rejection clips for Class R fuses.
- .4 Verify correct fuses fitted to assigned electrical circuit.
- .5 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

3.03 IDENTIFICATION

- .1 Identify distribution panelboards and breakers and switches with identification nameplates.
- .2 Nameplate for Each Panelboard:
 - .1 Manufacturer Nameplate: In accordance with CSA requirements and identify fault current that panel including breakers are built to withstand.
 - .2 Identification Nameplate: Size 4 engraved, unless otherwise noted.
- .3 Nameplate for each circuit breaker and disconnect switch in distribution panelboards: Size 2 engraved, unless otherwise noted.
- .4 Breakers in branch circuit panelboards: Identify in permanent manner with typed circuit directories identifying circuit number and type and location of loads supplied from each breaker. Mount directories in plastic envelope at inside of panel. Include copies of panelboard directories in O&M manuals.

3.04 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing and Verification:
 - .1 Inspect, start-up, test and verify products for:
 - .1 Correct system and component installation.
 - .2 Correct breakers and fuse types and sizes.
 - .3 Correct cable wiring and termination.
 - .4 Correct grounding.
 - .5 Correct and completed system start-up.
 - .2 Check connections and operations.
 - .3 Verify openings and conduit entries of surface mounted enclosures and drip shields are watertight.
 - .4 Perform adjusting and settings as recommended by manufacturer, and in accordance with Section 26 05 70 - Electrical Testing. Refer to coordination studies for settings.
- .2 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI):
 - .1 ANSI C12.1-[2022], Electric Meters - Code for Electricity Metering.
 - .2 ANSI C12.19-[2021], Utility Industry End Device Data Tables.
 - .3 ANSI C12.20-[2015], Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes.
- .2 CSA Group (CSA):
 - .1 CSA C22.2 No. 229-[17], Switching and Metering Centres.
- .3 Government of Canada:
 - .1 Measurement Canada PS-E-05-[2001(Rev. 1, 2017)], Provisional Specification for the Approval of Type of Electricity Meters.
 - .2 Measurement Canada PS-E-17-[2022], Provisional Specifications for the Approval of Type, Verification and Sealing of Electricity Meters with Remote Display Modules.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit compliance certificates, and testing and verification reports.

2. Products

2.01 GENERAL

- .1 Review metering requirements and where meter centres incorporating centralized metering, current transformers (CTs) and potential transformers (PTs) installed in common metering cabinet can be advantage in minimizing costs and space, provide for such configurations. Submit such proposals for review during shop drawing submission.
- .2 Provide meters and accessories, operating at voltages, suiting intended applications. Refer to drawings.
- .3 Include for complete installation, connection, and testing in accordance with manufacturer instructions and recommendations, suiting intended applications.
- .4 Provide metering approved by AHJ.
- .5 Where used for revenue billing applications, provide Measurement Canada approved metering.

2.02 SERVICE ENTRANCE MAST KITS

- .1 Mast kits:
 - .1 Suitable for Place of Work and in accordance with requirements of electrical utility.
 - .2 Approved by AHJ.
- .2 Kits include parts suiting intended applications, including:
 - .1 Entrance caps.
 - .2 Guy attachments with oval eyes and brackets.
 - .3 Heavy-duty spool racks.
 - .4 Drop wire hook bracket.
 - .5 Service mast wire holders.
 - .6 Male reducers.
 - .7 Roof flanges with neoprene/steel collars.
 - .8 Pipe straps with lag bolts.
 - .9 Mast couplers.
 - .10 U-bolt mast clamps.
 - .11 Support clamps.
 - .12 Masts.
 - .13 Female reducers.
 - .14 Meter socket bracket with mounting bracket.
 - .15 Ancillary mounting component and hardware.

2.03 ELECTRICAL UTILITY METERING SOCKETS AND BASES

- .1 Features:
 - .1 CSA certified and labeled.
 - .2 NEMA 3R weatherproof, unless otherwise noted, enamel painted steel enclosure with hub openings and knockouts to suit intended applications.
 - .3 From 4 jaw to 7 jaw type meter bases, suiting intended applications, and in accordance with requirements of AHJ.
 - .4 For overhead, underground and combination overhead/underground services, suiting intended applications.
 - .5 Meter seal rings.
- .2 Ratings:
 - .1 As noted.
- .3 Confirm exact model type and number with electrical utility.
- .4 Provide conduit and fish cord in accordance with requirements of electrical utility.

2.04 UTILITY METERING CABINETS

- .1 Features:
 - .1 CSA certified and labeled, and approved by AHJ for mounting of utility meters.
 - .2 Meter sockets: From 4 jaw to 7 jaw type meter bases, and with ratings, suiting intended applications. Refer to meter socket specifications.

- .3 Complete with knockouts and conduit entries, sealing and gasketing, mounting hardware, and padlocking provisions.
- .4 Indoors and Climate-Controlled: Surface wall-mounting, NEMA 2 or 12, with sprinkler protection provisions, enamel painted steel construction.
- .5 Outdoors and Non-Climate Controlled: Surface wall mounting, exterior weatherproof, NEMA 3R, enamel painted steel construction.
- .2 Provide conduit and fish cord in accordance with requirements of electrical utility.

2.05 UTILITY POLY PHASE ELECTRICITY METERING

- .1 Solid state and poly-phase metering with features as follows:
 - .1 Measurement Canada approved, displaying verification mark.
 - .2 CSA certified and labeled, and approved by AHJ.
 - .3 In accordance with ANSI C12.1, ANSI C12.19 and ANSI C12.20.
 - .4 Accuracy: +/-0.2.
 - .5 Electronic circuit boards fit together performing various functions.
 - .6 Transformer input for current and resistive divider input for voltage.
 - .7 Analogue-to-digital conversion and measurement processing.
 - .8 Register, load-profile, real-time clock and communications processing.
 - .9 Input and output board for pulse accumulation or event notification.
 - .10 5 measurement levels.
 - .11 Upgradable firmware.
 - .12 Error and event logging.
 - .13 Onsite monitoring system.
 - .14 Flexible configuration for various metering applications.
 - .15 Auto-ranging power supply.
 - .16 Register data and program information retained in non-volatile memory in event of power failure.
 - .17 Operations on programmable LCD screen.
 - .18 Energy measurements and calculations: Wh, VARh, VAh, A2h, V2h, Ah and Vh.
 - .19 Demand measurements: instantaneous values updated every second; maximum, present, previous, projected, cumulative, continuous cumulative and coincident demand values.
 - .20 Power quality.
 - .21 Voltage quality.
 - .22 Phase to phase or phase to ground event detection.
 - .23 3 levels of sags.
 - .24 3 levels of swells.
 - .25 3 levels of voltage imbalances.
 - .26 3 levels of current imbalances.
 - .27 3 classes of interruptions.
 - .28 Harmonics:
 - .1 Per phase instantaneous %THD V and %TDD I.
 - .2 Prompt for peak demand current.
 - .3 Per phase data is displayable.

- .4 ANSI and IEC calculation.
- .5 Harmonic distortion check.
- .2 Other features:
 - .1 Pulse output and inputs.
 - .2 PF (average/minimum/instantaneous).
 - .3 RS232/RS485 and Ethernet communications.
 - .4 Factory programmed to provide custom Owner requirements suiting specific onsite applications.
 - .5 Mounts to coordinated socket base with jaws as required.
 - .6 CTs/PTs as required.
 - .7 Auxiliary outputs for monitoring connection to BAS systems. Coordinate and confirm requirements with Division 25 BAS vendor.
 - .8 Where mounted in non-climate-controlled environments: Weather-resistant, corrosion-resistant and vandal-resistant.
 - .9 Operating Temperature: Minus 40°C to 85°C.

2.06 PANEL MOUNT BASIC ELECTRICITY METERING

- .1 Applications:
 - .1 Basic power and energy meter for feeders, loads or tenant space.
 - .2 Cost allocation and submetering.
 - .3 Suitable for operation on 120/208 VAC and 600 VAC suiting intended applications. Refer to single line diagram.
- .2 Microprocessor based, digital metering unit as follows:
 - .1 In accordance with ANSI C12.1 and ANSI C12.20.
 - .2 Approved by AHJ.
 - .3 Panel-mount, or DIN rail mounted, suiting intended applications.
 - .4 Measure and display: Voltage, current, frequency and time.
 - .5 Calculate and display kW, kWh, kW demand, ampere demand, kVA, kVA demand, kVAr and kVArh.
 - .6 LCD back-lit display screen.
 - .7 Inputs/outputs, contacts, RS232/Ethernet interface for communications to remote printer, LAN or building automation system (BAS).
 - .8 Current transformers, potential transformers and control wiring.
 - .9 Operating Temperature: Minus 25° to 85°C.

2.07 PANEL MOUNT ADVANCED ELECTRICITY METERS

- .1 Applications:
 - .1 Provides real-time energy management information for monitoring and analysis of feeders and critical loads.
 - .2 Analysis of efficiency, losses and capacity.
 - .3 Bill verification, cost allocation and sub-metering.
 - .4 Power quality compliance monitoring.
 - .5 Control of loads, generators or other equipment.

- .6 Interfaces with power monitoring software or other energy management or automation systems.
- .7 Suitable for operation on 120/208 VAC and 600 VAC suiting intended applications. Refer to single line diagram.
- .2 Microprocessor based digital metering unit as follows:
 - .1 In accordance with ANSI C12.1 and ANSI C12.20.
 - .2 Approved by AHJ.
 - .3 Panel-mount, or DIN rail mounted, suiting intended applications.
 - .4 LCD back-lit display.
 - .5 3-phase, 4-quadrant metering, class 0.5 revenue-accurate.
 - .6 Voltage, current, power, frequency, power factor, demand, energy, and time-of-use metering.
 - .7 64 samples/cycle waveform capture, dip/swell monitoring, and harmonics measurement (up to 31st).
 - .8 Sequence-of-events, coincident minimum/maximum, historical trends.
 - .9 High-speed snapshot recording, 1 ms resolution timestamping.
 - .10 Multiple analogue inputs and outputs, analogue outputs, digital status/counter inputs, and digital control/pulse outputs.
 - .11 Multiple setpoints for alarms and control, 1 second response, multi-condition, and call out on alarm.
 - .12 Multiple communication ports: Ethernet, modem, RS-485, and front panel optical.
 - .13 Protocols: Modbus RTU slave, Modbus TCP, DNP 3.0, MV-90.
 - .14 Ethernet and modem gateways to 31 devices on RS-485 port.
 - .15 On-board web server, email for alarms and data logs.
 - .16 Operating Temperature: Minus 25° to 85°C.
- .3 Cabling:
 - .1 Provide conductors in accordance with system manufacturer requirements.

2.08 METER STACK MODULES

- .1 Factory assembled modular metering stacks as follows:
 - .1 Manufactured to applicable CSA Standards including CSA C22.2 No. 229 and electrical code.
 - .2 With configuration of stacked meter units as noted, for metering of individual tenant space panels.
 - .3 Suitable for 120/240 VAC single phase, or 120/208 VAC, three phase systems, as noted and suiting intended applications. Ampacity rating suiting intended applications.
 - .4 Modular construction.
 - .5 Separate barriered meter socket and individual tenant space main breaker and wireway sections.
 - .6 Bolt-on, moulded case, individual tenant space sub-service breaker sized suiting intended application.
 - .7 Factory phased balanced.
 - .8 Enclosed horizontal bus.
 - .9 Equipment ground bars and neutral bars.

- .10 Meter socket base and jaws coordinated with meter provided. Prior to ordering, review jaw requirements with Consultant.
- .11 NEMA 2 or 12, with sprinkler-protection provisions including drip shield.
- .12 Boxes constructed of code gauge galvanized steel, with factory painted manufacturer standard ANSI grey baked acrylic-enamel finish.
- .13 Wireway
- .14 Knockouts for feeder entry/exit.
- .15 Sized accommodating wiring bending radii as required by electrical code.
- .16 Auxiliary devices, suiting intended applications.

2.09 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Metering:
 - .1 Itron.
 - .2 Schneider (PML).
 - .3 QMC.
 - .4 Carma Industries.
- .2 Meter Stack Modules:
 - .1 Eaton.
 - .2 Schneider.
 - .3 Siemens.
 - .4 ABB.

3. Execution

3.01 PROVISIONS FOR UTILITY METERING

- .1 Review with and coordinate utility metering requirements with electrical utility. Provide products in accordance with electrical utility standards including ANSI level of accuracy.
- .2 Coordinate and arrange for electrical utility incoming service work.
- .3 Provide meter enclosure with base and accessories and install in accordance with manufacturer instructions and in accordance with electrical utility requirements. Connect complete.
- .4 Meters, CTs and PTs for local electrical utility metering are typically supplied by local electrical utility. Where meters, CTs and PTs are not supplied by electrical utility, provide in accordance with utility requirements and suiting intended applications.
- .5 Obtain required inspections, approvals and compliance certificates.

3.02 INSTALLATION OF METERING CABINETS AND BASES FOR UTILITY METERING

- .1 Coordinate and arrange for electrical utility incoming service work, including providing meters.
- .2 Provide metering cabinets and conduit and install in accordance with electrical utility requirements. Install cabinet in locations with adequate clearance around cabinet for access for operation and maintenance. Provide supporting hardware. Extend empty conduit from cabinets to metering compartments of switchboard or to main disconnect or to meter base, suiting intended applications.

- .3 Mount meter base with socket in accordance with requirements of electrical utility and as reviewed with Consultant.
- .4 Confirm exact location of metering cabinet with electrical utility and review with Consultant.
- .5 Obtain inspections, approvals and compliance certificates.

3.03 INSTALLATION OF ELECTRICITY METERING

- .1 Provide meters and install in locations as reviewed with Consultant.
- .2 Mount in locations as panel mounted or DIN rail mounted, suiting intended applications. Where mounted in switchboards or panelboards, coordinate installations with manufacturers of switchboards or panelboards.
- .3 Comply with manufacturer installation instructions.
- .4 Refer to single line diagram for locations and additional requirements.
- .5 Install current transformers to encircle conductors.
- .6 Run and install wiring in conduit, connecting metering to devices.
- .7 Connect and test for proper operation.
- .8 Obtain inspections and compliance certificates for metering, in accordance with requirements of AHJ.

3.04 INSTALLATION OF METER STACK MODULES

- .1 Provide modules and install units in accordance with manufacturer instructions, and as noted.
- .2 Connect feeders from panelboards. Coordinate meter socket requirements with supplier of meters.
- .3 Install meters, breakers and accessories.
- .4 Ground and bond components.

3.05 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing and Verification:
 - .1 Arrange for manufacturer authorized technician to inspect, test, program, verify, certify and commission system after installation is complete.
 - .2 Inspect, start-up, test and verify products.
 - .3 Adjust and calibrate meters as required.
 - .4 Check connections and operations.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 94.1-[15(R2020)], Enclosures for Electrical Equipment, Non-Environmental Considerations (Tri-National Standard with NMJ-J-235/1-ANCE-2015 and UL 50).
- .2 National Electrical Manufacturers Association (NEMA):
 - .1 ANSI/NEMA 250-[2020], Enclosures for Electrical Equipment (1000 Volts Maximum).

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Identify:
 - .1 Types and locations.
 - .2 Ratings and dimensions.
 - .3 Lock keying requirements, as applicable.
- .3 Submit inspection and verification reports.

2. Products

2.01 CABINETS AND ENCLOSURES - GENERAL

- .1 Standards: In accordance with CSA C22.2 No. 94.1 and ANSI/NEMA 250.
- .2 Sizing, construction, mounting and types: As noted.
- .3 Unless otherwise noted, include hinged doors, handle operator with lock and two keys and provisions for padlocking.
- .4 Lock Keying: Suiting user requirements as confirmed with Consultant.
- .5 Type "E" Empty: Surface return flange with mounting, suiting intended applications.
- .6 Type "T" Terminal: Surface return flange with mounting as required, containing sheet steel or 19 mm G1S plywood backboard, suiting intended applications.
- .7 Physical Size: As noted, suiting intended applications.

2.02 STEEL CABINETS AND ENCLOSURES

- .1 Enclosures sized up to 600 mm x 600 mm constructed with minimum 16 gauge mild steel, minimum 14 gauge for larger enclosures.
- .2 Unless otherwise noted, manufacturer standard ANSI gray enamel, weather and corrosion-resistant finish.
- .3 NEMA Ratings:
 - .1 Climate-controlled Environments: NEMA 2 unless otherwise noted, with drip shield.
 - .2 Non-climate-controlled Environments: NEMA 4, unless otherwise noted.
- .4 Entire enclosure capable of withstanding maximum impact force of at least 86 MN/m² area without rupture of material.
- .5 Body stiffeners provided in larger enclosures for extra rigidity.
- .6 Removable enclosure panels with formed edges, galvanized steel external fasteners removable only from inside enclosure.
- .7 Hot dipped galvanized mounting rails adjustable horizontally and vertically enabling mounting of equipment within housing.
- .8 Rails: 14 mm holes and 50 x 14 mm slots on 100 mm centres for horizontal adjustment.
- .9 Holes in side panel flanges in 60 mm or other required increments for vertical adjustment.
- .10 Surface Mounted Units:
 - .1 Conduit penetrations using rain-tight fittings.
 - .2 Drip Shield: Bolted to enclosure, designed to shed water.
- .11 Doors: 3-point latching, gasketed, stainless steel hinged, solid, with key locking handle operator and padlocking means.
- .12 Covers: Bolted to enclosures.
- .13 In-door polycarbonate viewing window: Cabinets as noted.
- .14 Ventilation panel constructed to allow air circulation and preventing entry of foreign objects, wildlife and vermin.
- .15 Door Interlocks: In accordance with Section 26 18 41 - Interlock Systems.
- .16 Bonding stud provided on door and grounding stud in enclosure.
- .17 Enclosure construction to allow configuration of single or ganged enclosures as noted.
- .18 Mounting:
 - .1 Surface wall-mounting with external metal C-type channel supports and ancillary devices.
 - .2 Floor-mounting with suitable metal base for securing to floor or concrete pad.
 - .3 Floor-mounting with floor stands welded to enclosure.
 - .4 Recessed wall-mounting with trim.

2.03 STAINLESS STEEL CABINETS AND ENCLOSURES

- .1 Enclosure sized up to 600 mm x 600 mm constructed with minimum 16 gauge stainless steel, minimum 14 gauge for larger enclosures.
- .2 Weather and corrosion-resistant, natural stainless steel with smooth brushed finish.
- .3 NEMA Ratings:

- .1 Climate-controlled environments: NEMA 2 unless otherwise noted, with drip shield.
- .2 Non-climate-controlled environments: NEMA 4 unless otherwise noted.
- .4 Entire enclosure capable of withstanding maximum impact force of at least 86 MN/m² area without rupture of material.
- .5 Body stiffeners provided in larger enclosures for extra rigidity.
- .6 Removable enclosure panels with formed edges, external fasteners removable only from inside enclosure.
- .7 Hot dipped galvanized mounting rails adjustable horizontally and vertically to enable mounting of equipment within housing.
- .8 Rails: 14 mm holes and 50 x 14 mm slots on 100 mm centres for horizontal adjustment.
- .9 Holes in side panel flanges in 60 mm or other increments for vertical adjustment.
- .10 Surface Mounted Units:
 - .1 Conduit penetrations using rain-tight fittings.
 - .2 Drip Shield: Bolted to enclosure, designed to shed water.
- .11 Doors: 3-point latching, gasketed, stainless steel hinged, solid, with key locking handle operator and padlocking means.
- .12 Covers: Bolted to enclosures.
- .13 In-door polycarbonate viewing window: Cabinets as noted.
- .14 Ventilation panel constructed to allow air circulation and preventing entry of foreign objects, wildlife and vermin.
- .15 Door Interlocks: In accordance with Section 26 18 41 - Interlock Systems.
- .16 Bonding stud provided on door and grounding stud in enclosure.
- .17 Enclosure construction to allow configuration of single or ganged enclosures as noted.
- .18 Mounting:
 - .1 Surface wall-mounting with external metal C-type channel supports and ancillary devices.
 - .2 Floor-mounting with suitable metal base for securing to floor or concrete pad.
 - .3 Floor-mounting with floor stands welded to enclosure.
 - .4 Recessed wall-mounting with trim.

2.04 NON-METALLIC CABINETS AND ENCLOSURES

- .1 Molded fiberglass polyester enclosure with matching cover that is easily punched, cut, or drilled.
- .2 Enhanced UV inhibitors protect against outdoor weathering.
- .3 Manufacturer standard NEMA gray, weather and corrosion-resistant finish.
- .4 NEMA 4X corrosion-resistant rating.
- .5 Operating temperatures between 130°C and minus 40°C.
- .6 Entire enclosure capable of withstanding maximum impact force of at least 6.78 J without rupture of material.

- .7 Surface Mounted Units:
 - .1 Conduit penetrations using rain-tight fittings.
 - .2 Moulded-in drip shield: Designed to shed water.
- .8 In-door polycarbonate viewing window: Cabinets as noted.
- .9 Door Interlocks: In accordance with Section 26 18 41 - Interlock Systems.
- .10 Bonding stud provided on door and grounding stud in enclosure.
- .11 Enclosure construction to allow configuration of single or ganged enclosures as noted.
- .12 Mounting:
 - .1 Surface wall-mounting with external metal C-type channel supports and ancillary devices.
 - .2 Floor-mounting with suitable metal base for securing to floor or concrete pad.
 - .3 Floor-mounting with floor stands welded to enclosure.
 - .4 Recessed wall-mounting with trim.

2.05 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Cabinet and Enclosures:
 - .1 Hammond.
 - .2 nVent (Hoffman).
 - .3 Wiegmann.
 - .4 Legrand.

3. Execution

3.01 INSTALLATION

- .1 Provide cabinets and enclosures, pre-assembled or assembled onsite, as noted. Provide lock keying requirements as reviewed with Consultant.
- .2 Assemble and install cabinets and enclosures in accordance with manufacturer instructions and mount on building structure with channels, supports and fastenings.
- .3 Mount plumb, true and square to building lines. Flush or surface mounted as noted.
- .4 Install with clearance for access for operation and maintenance.
- .5 Secure in place independent of connecting conduit, secure into position and make connections.
- .6 Mount with top not higher than 2 m above finished floor, unless otherwise noted.
- .7 Install terminal block as required for Type T cabinets.
- .8 Provide supplemental mounting requirements, as noted.
- .9 Mount accessories and equipment in cabinets and enclosures.
- .10 Do not run conduit with entries through top of cabinets or enclosures.
- .11 Seal conduit penetrations with water-tight sealant unless rain-tight fittings are provided. Provide sealant that does not compromise NEMA rating of enclosure.
- .12 Prior to ordering, review finishes and keying requirements with Consultant.

- .13 Provide grounding and bonding.

3.02 IDENTIFICATION

- .1 Provide products with engraved lamicoid nameplate with nomenclature reviewed with Consultant.
- .2 Identification Nameplates: Size 2 unless otherwise noted, indicating voltage and phase and system name.

3.03 FIELD QUALITY CONTROL

- .1 Product inspection and verification of following:
 - .1 Types as specified for applications and environment.
 - .2 Damage, scratches or dents.
 - .3 If set or mounted level and secured in position.
 - .4 Conduit connections and penetrations properly made.
 - .5 Securing hardware, hinges, handles and locks for proper operation.
 - .6 Accessories included as noted.
 - .7 Nameplates provided.
- .2 Prepare inspection and verification reports, signed by technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 42-[10(R2020)], General Use Receptacles, Attachment Plugs and Similar Wiring Devices.
 - .2 CSA C22.2 No. 42.1-[13(R2017)], Cover Plates for Flush-Mounted Wiring Devices (Bi-National Standard, with UL 514D).
 - .3 CSA C22.2 No. 55-[15(R2020)], Special Use Switches.
 - .4 CSA, C22.2 No. 308-[18 (R2022)], Cord Reels and Multi-outlet Assemblies.
 - .5 CAN/CSA C22.2 No. 111-[18], General-Use Snap Switches (Trinational Standard with UL 20 and NMX-J-005-ANCE).
 - .6 CSA C22.2 No. 144.1-[16(R2020)], Ground-Fault Circuit-Interruptioners (Tri-National standard, with UL 943 and NMX-J-520-ANCE).
 - .7 CSA C22.2 No. 270-[16(R2021)], Arc Fault Protective Devices.
- .2 Underwriter Laboratories (UL):
 - .1 UL 1449-[2021], Standard for Surge Protective Devices.
 - .2 UL 1669A-[2010], Outline of Investigation for Outlet Branch Circuit Arc-Fault Circuit-Interruptioners.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Submit each type and clearly identify.
- .3 Samples:
 - .1 Submit samples of each typical wiring device, faceplates, finishes and colours.
 - .2 Mount to sample board, clearly labelling devices and finishes.
 - .3 Do not order devices without review with and recommended for acceptance by Consultant.
- .4 Submit testing and verification reports.

2. Products

2.01 GENERAL

- .1 CSA certified, or ULC listed and labeled products.
- .2 Ratings and Types: As specified herein or as noted on drawings.

- .3 Provide wiring devices (switches and receptacles) of one manufacturer throughout project.
- .4 Unless otherwise noted, devices typically are flush types that fit flush in standard single gang wall boxes.
- .5 20 A Receptacles: T- slot type of respective series of respective receptacles.
- .6 In addition to devices specified herein, refer to drawings for requirements for other devices.

2.02 SWITCHES

- .1 Ratings and Poles:
 - .1 15 A and 20 A, and as noted.
 - .2 347 VAC, 277 VAC and 120 VAC, and as noted and suiting intended applications.
 - .3 Single pole, double pole, three-way and four-way switches, and as noted.
 - .4 In accordance with CSA C22.2 No. 55 and CAN/CSA C22.2 No. 111.
- .2 Manually operated general purpose AC toggle type switches with following features:
 - .1 Heavy duty, industrial grade.
 - .2 Heavy duty nylon toggle and elastomer rocker, permanently lubricated assembly.
 - .3 One-piece thermoset colour coded base and one-piece high impact-resistant thermoplastic front face.
 - .4 Steel-nickel plated bridge, and one-piece rivetless copper alloy spring contact arm and terminal plate.
 - .5 Brass binding head screws.
 - .6 One-piece integral grounding terminal and stainless-steel automatic grounding clips.
 - .7 Silver alloy contacts.
 - .8 Suitable for back and side wiring.
- .3 Manually operated general purpose decorative style AC rocker type switches with following features:
 - .1 Specification grade.
 - .2 Nylon or thermoplastic decorative style rocker, permanently lubricated assembly.
 - .3 Nickel-plated bridge with automatic grounding clips.
 - .4 Brass binding head screws.
 - .5 Silver alloy contacts.
 - .6 Thread cleaning captive mounting screw.
 - .7 Suitable for back and side wiring.
- .4 Locking Switches:
 - .1 Locking operated with key, fully compatible and rated for lamp loads, and up to 80% of rated capacity of motor loads and heating loads.
 - .2 Heavy duty, industrial grade.
 - .3 Heavy duty nylon key guide.
 - .4 One-piece thermoset colour coded base and one-piece high impact-resistant thermoplastic front face.

- .5 Steel-nickel plated bridge, and one-piece rivetless copper alloy spring contact arm and terminal plate.
- .6 Brass binding head screws.
- .7 One-piece integral grounding terminal and stainless-steel automatic grounding clips.
- .8 Silver alloy contacts.
- .9 Back and side wiring.
- .10 Key for locking.
- .5 Illuminated toggle switches with features as follows:
 - .1 Heavy duty, industrial grade.
 - .2 Heavy duty nylon toggle and elastomer rocker, permanently lubricated assembly.
 - .3 Illuminated LED pilot light in toggle.
 - .4 One-piece thermoset colour coded base and one-piece high impact-resistant thermoplastic front face.
 - .5 Steel-nickel plated bridge, and one-piece rivetless copper alloy spring contact arm and terminal plate.
 - .6 Brass binding head screws.
 - .7 One-piece integral grounding terminal and stainless-steel automatic grounding clips.
 - .8 Silver alloy contacts.
 - .9 Back and side wiring.
 - .10 Operate as follows and as noted:
 - .1 Illuminated light ON with load ON.
- .6 Illuminated rocker switches with features as follows:
 - .1 Specification grade.
 - .2 Nylon or thermoplastic decorative style rocker, permanently lubricated assembly.
 - .3 Illuminated LED pilot light in rocker.
 - .4 Nickel-plated bridge with automatic grounding clips.
 - .5 Brass binding head screws.
 - .6 Silver alloy contacts.
 - .7 Thread cleaning captive mounting screw.
 - .8 Back and side wiring.
 - .9 Operate as follows and as noted:
 - .1 Illuminated light ON with load ON.
- .7 Door jamb switches with features as follows:
 - .1 Pressure sensitive door switches with normally ON momentary metal pushbutton, zinc plated steel box, cover plates and wire leads.
 - .2 Rated 3A, 125V AC.
 - .3 Suitable for flush installation.
 - .4 Operation: Light is ON when door is open.
- .8 Modular Connected Switches:
 - .1 AC toggle type switches:

- .1 Heavy duty, industrial grade, modular.
- .2 Pig tail connector terminations:
 - .1 Easy relocations of switches.
 - .2 Eliminates exposed live terminals on device.
 - .3 Right angle terminal snap-in connection.
- .3 Heavy duty nylon toggle and elastomer rocker, permanently lubricated assembly.
- .4 One-piece thermoset colour coded base and one-piece high impact-resistant thermoplastic front face.
- .5 Steel-nickel plated bridge, and one-piece rivetless copper alloy spring contact arm and terminal plate.
- .6 Brass binding head screws.
- .7 One-piece integral grounding terminal and stainless-steel automatic grounding clips.
- .8 Silver alloy contacts.
- .2 AC rocker type switches:
 - .1 Specification grade, modular.
 - .2 Pig tail connector terminations:
 - .1 Easy relocations of switches.
 - .2 Eliminates exposed live terminals on device.
 - .3 Right angle terminal snap-in connection.
 - .3 Nylon or thermoplastic decorative style rocker, permanently lubricated assembly.
 - .4 Nickel-plated bridge with automatic grounding clips.
 - .5 Brass binding head screws.
 - .6 Silver alloy contacts.
 - .7 Thread cleaning captive mounting screw.
- .9 Luminaire switches connected to isolated power: 2-pole type and in red colour finish.
- .10 Hazardous Locations: Explosion proof, front operated switches, suitable for Class 1 Division 2 applications, unless otherwise noted. Prior to ordering, review classification requirements with Consultant. Coordinate requirements, ensure compatibility with connected equipment.

2.03 RECEPTACLES

- .1 Standard Duplex Straight Blade Receptacles:
 - .1 Extra heavy duty, Specification grade.
 - .2 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
 - .3 In accordance with CSA C22.2 No. 42.
 - .4 One-piece RTP reinforced thermoplastic base and one-piece high impact-resistant flush, nylon front face.
 - .5 One-piece nickel-plated brass mounting strip with automatic self-grounding clips.
 - .6 Nickel-plated brass wiring clamps with brass line terminal screws.
 - .7 Front circuit identification area.
 - .8 Suitable for No. 10 AWG for back and side wiring.

- .9 Break-off links for use as split receptacles.
- .10 Eight back wired entrances, four side wiring screws.
- .11 Triple wipe brass contacts and rivetted grounding contacts.
- .12 Square head, brass center rivets.
- .2 Decorative Duplex Straight Blade Receptacles:
 - .1 Extra heavy duty.
 - .2 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
 - .3 In accordance with CSA C22.2 No. 42.
 - .4 RTP reinforced thermoplastic base and high impact-resistant flush, decorative style nylon front face.
 - .5 One-piece galvanized steel mounting strip with automatic self-grounding stainless steel clips.
 - .6 Plated brass wiring clamps with brass terminal screws.
 - .7 Back and side wiring.
 - .8 Break-off links for use as split receptacles.
 - .9 Eight back wired entrances, four side wiring screws.
 - .10 Triple wipe brass contacts and brass grounding contacts.
- .3 Single Standard Straight Blade Receptacles:
 - .1 Extra heavy duty, specification grade.
 - .2 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
 - .3 PBT thermoplastic body and nylon face.
 - .4 One-piece brass mounting strip with automatic self-grounding stainless steel clips.
 - .5 Brass power contacts and brass ground contacts.
 - .6 Back and side wiring.

2.04 SPECIAL WIRING DEVICES

- .1 Ground Fault Circuit Interrupting (GFCI) Receptacles:
 - .1 Standard GFCI Receptacles:
 - .1 Heavy-duty grade, CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, duplex, ULC Class "A", Group One.
 - .2 In accordance with CSA C22.2 No.42 and CSA C22.2 No. 144.1.
 - .3 Automatically monitor GFCI functionality.
 - .4 Loss of GFCI protection disables power and provides visual and/or audible indication of loss of protection.
 - .5 Incorrect wired line conductor prevents power to receptacle.
 - .6 Automatic self-test diagnostics testing within every 30 seconds.
 - .7 Housing: High impact and UV-resistant thermoplastic nylon construction.
 - .8 LED status lights:
 - .1 Green: Power ON.
 - .2 Red: Trip condition/ground fault.
 - .3 Flashing Red: End of life.
 - .9 10 KA short circuit current rating, unless otherwise noted.

- .10 Internal back wiring clamp and guide for quick and secure termination.
- .11 Brass power contacts, brass ground straps and zinc-plated mounting straps.
- .12 Zinc-plated steel mounting screws.
- .13 Triple wipe contacts construction.
- .14 Fits in standard single gang wall box.
- .2 Additional To Standard Features for Special GFCI Receptacles:
 - .1 Tamper-Resistant GFCI Receptacles:
 - .1 Features of Standard GFCI Receptacles.
 - .2 Tamper-resistant with shutter design.
 - .2 Weather-Resistant GFCI Receptacles:
 - .1 Features of Standard GFCI Receptacles.
 - .2 Weather-resistant against UV and corrosion.
 - .3 Tamper and Weather-Resistant GFCI Receptacles:
 - .1 Features of Standard GFCI Receptacles.
 - .2 Tamper-resistant with shutter design.
 - .3 Weather-resistant against UV and corrosion.
 - .4 Alarm GFCI Receptacles:
 - .1 Features of Standard GFCI Receptacles.
 - .2 Audible alarm with silencing feature.
 - .3 Tamper-resistant with shutter design.
 - .5 Nightlight GFCI Receptacles:
 - .1 Features of Standard GFCI Receptacles.
 - .2 2-LED nightlights.
 - .3 Tamper-resistant with shutter design.
 - .6 Modular Connected GFCI Receptacles:
 - .1 Features of Standard GFCI Receptacles.
 - .2 Pig tail connector terminations:
 - .1 Easy relocations of switches.
 - .2 Eliminates exposed live terminals on device.
 - .3 Right angle terminal snap-in connection.
- .2 Isolated Ground Duplex Receptacles:
 - .1 Extra heavy duty, Specification grade.
 - .2 Identification IG symbol on face.
 - .3 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
 - .4 Typically, orange finish.
 - .5 20 A feed-through protection.
 - .6 In accordance with CSA C22.2 No. 42.
 - .7 One-piece RTP reinforced thermoplastic base and one-piece high impact-resistant flush, nylon front face.
 - .8 One-piece brass mounting strip with automatic self-grounding clips.
 - .9 Nickel-plated brass wiring clamps with brass line terminal screws.
 - .10 Front circuit identification area.

- .11 Suitable for No. 10 AWG for back and side wiring.
 - .12 Break-off links for use as split receptacles.
 - .13 Eight back wired entrances, four side wiring screws.
 - .14 Triple wipe brass contacts and rivetted grounding contacts.
 - .15 Green grounding screw connected directly to grounding contacts.
 - .16 Insulation barrier isolates ground contacts from mounting straps.
 - .17 Square head, brass center rivets.
- .3 Arc-Fault Circuit Interrupting (AFCI) Duplex Receptacles:
- .1 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
 - .2 In accordance with CSA C22.2 No. 42 and CSA C22.2 No. 270.
 - .3 Tamper-resistant and self-grounding construction features.
 - .4 Green power ON LED indicator.
 - .5 Automatically tests AFCI each time reset button is pressed in place.
 - .6 No reset when tested if AFCI functionality is compromised.
 - .7 Meets or exceeds UL requirements for tripping time on series and parallel arcs.
 - .8 RTP reinforced thermoplastic base and flush nylon front face.
 - .9 One-piece mounting strip with automatic self-grounding clips.
 - .10 Back and side wired.
 - .11 Fits in standard single gang wall box.
- .4 Power Receptacles with Higher Power USB Charging Ports:
- .1 2- USB ports, 60 W (20 V@ 2.5 A + 5 V @ 2 A), Type A and Type C port configurations, class 2.0, 3.0 and 3.1.
 - .2 USB Type-C: Capable of 5 VDC, 9 VDC, 15 VDC, and 20 VDC with maximum power output of 50W.
 - .3 USB Type A: Capable of 5VDC with maximum power output of 10W.
 - .4 Smart chip recognizes and optimizes charging requirements of individual devices.
 - .5 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V rated, Specification Grade, duplex decorative style tamper-resistant power receptacles with thermoplastic body, brass triple-wipe contacts, steel straps and screws.
 - .6 Green LED indicator identifying USB power available.
 - .7 USB stainless steel ports.
 - .8 Tamper-resistant, back and side wired.
 - .9 Prior to ordering, review requirements for USB port configuration and 15 A or 20 A power receptacles with Consultant.
- .5 Tamper Resistant, Safety Shutter Duplex Receptacles:
- .1 Extra heavy duty, Specification grade.
 - .2 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
 - .3 In accordance with CSA C22.2 No. 42.
 - .4 Tamper-resistant cam action mechanism.
 - .5 One-piece reinforced thermoplastic base and one-piece high impact-resistant flush, nylon front face.
 - .6 One-piece brass mounting strip with automatic self-grounding clips.

- .7 Nickel-plated brass wiring clamps with brass line terminal screws.
- .8 Front circuit identification area.
- .9 Break-off links for use as split receptacles.
- .10 Back and side wired.
- .11 Triple wipe brass contacts and rivetted grounding contacts.
- .12 Square head, brass center rivets.
- .6 Surge Suppression Duplex Receptacles:
 - .1 Specification grade.
 - .2 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
 - .3 In accordance with CSA C22.2 No. 42.
 - .4 Typically, blue finish.
 - .5 Impact resistant nylon face.
 - .6 With surge protection indication light.
 - .7 One-piece steel mounting strip with automatic self-grounding clips.
 - .8 MOVs rated 240 joules/15000 A per mode in accordance with UL 1449.
 - .9 Surge symbol identification on face.
 - .10 Green grounding screw connected directly to grounding contacts.
 - .11 Back and side wired.
 - .12 Fits in standard single gang wall box.
- .7 Switched Receptacles for Automatic Receptacle Control:
 - .1 Wired Switched Controlled Duplex Receptacles:
 - .1 Industrial grade, decorative style.
 - .2 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
 - .3 In accordance with CSA C22.2 No. 42.
 - .4 Controlled by wired low voltage signal from occupancy sensor or other control.
 - .5 Auto ON/Auto OFF control.
 - .6 Control of additional downstream receptacles.
 - .7 Fully controlled duplex outlets for receptacles as noted.
 - .8 Half outlet controlled with split circuit for receptacles as noted.
 - .9 Permanently marked with symbol identifying controlled receptacle/outlet.
 - .10 Nylon face and body construction.
 - .11 One-piece brass mounting strip with automatic self-grounding stainless steel clips.
 - .12 Brass power contacts and brass terminal screws.
 - .13 Tamper-resistant with shutter design.
 - .14 Back and side wired.
 - .2 Wireless Switched Controlled Duplex Receptacles:
 - .1 Industrial grade, decorative style.
 - .2 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
 - .3 In accordance with CSA C22.2 No. 42.
 - .4 Wireless receiver.

- .5 Controlled by wireless low voltage signal from occupancy sensor or other control.
- .6 Auto ON/Auto OFF control.
- .7 Control of additional downstream receptacles.
- .8 Fully controlled duplex outlets for receptacles as noted.
- .9 Half outlet controlled with split circuit for receptacles as noted.
- .10 Permanently marked with symbol identifying controlled receptacle/outlet.
- .11 Nylon face and body construction.
- .12 One-piece brass mounting strip with automatic self-grounding stainless steel clips.
- .13 Brass power contacts and brass terminal screws.
- .14 Tamper-resistant with shutter design.
- .15 Back and side wired.
- .8 Receptacle Load Controllers:
 - .1 Unit provides connection between switch, occupancy sensors and controlled receptacles, suiting design intent as noted.
 - .2 Wired connection for wired systems.
 - .3 Wireless transmitter for wireless systems.
 - .4 Controls receptacles based on input from occupancy sensors.
 - .5 Heavy duty mechanically held, latching relays, with silver alloy contacts.
 - .6 Fail-safe mechanism turns on output in event of missing sensor.
 - .7 LED status indicator shows current load status and provides programming feedback.
 - .8 Power Failure Memory: When power interrupted, connected receptacles return to state prior to power interruption.
- .9 Permanently Controlled Marked Receptacles:
 - .1 Commercial Specification grade.
 - .2 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
 - .3 In accordance with CSA C22.2 No. 42.
 - .4 Fully controlled duplex outlets for receptacles as noted.
 - .5 Half outlet controlled with split circuit for receptacles as noted.
 - .6 Permanently marked with symbol identifying controlled receptacle/outlet.
 - .7 Nylon face and body construction.
 - .8 One-piece galvanized steel mounting strip with automatic self-grounding stainless steel clips.
 - .9 Brass power contacts and brass ground contacts.
 - .10 Back and side wired.
- .10 Electric Range Receptacles:
 - .1 Industrial grade.
 - .2 NEMA type 14-50R, 50 A, 125/250 V, 3-pole, 4-wire single receptacles.
 - .3 Thermoplastic receptacle construction.
 - .4 Flush mount.
 - .5 Heavy-gauge, double-wire copper alloy contacts.

- .6 Steel faceplates.
- .11 Clothes Dryer Receptacles:
 - .1 Industrial grade.
 - .2 NEMA type 14-30R, 30 A, 125/250 V, 3-pole, 4-wire single receptacles.
 - .3 Thermoplastic receptacle construction.
 - .4 Flush mount.
 - .5 Heavy-gauge, double-wire copper alloy contacts.
 - .6 Steel faceplates.
- .12 Clock Hanger Outlets:
 - .1 Commercial Specification grade, recessed, tamper-resistant single receptacle.
 - .2 CSA type 5-15R, 15 A, 125 V, 3 wire, grounding type receptacles.
 - .3 Removable clock hanger hook with ability to hang items up to 1 kg.
 - .4 Stainless steel wall plate.
 - .5 Installation in flush outlet box.
- .13 Twist-Lock Receptacles:
 - .1 CSA type for receptacles as noted.
 - .2 Operation: Turn to lock together when mated to prevent accidental disconnection. Male connector with curved prongs that plug into receptacle and then are twisted to lock into place.
- .14 Chemical and Impact-Resistant Switches:
 - .1 One-piece nickel-plated brass strap.
 - .2 Cam control and spring actuator.
 - .3 One-piece toggle moulded from chemical resistant, impact-resistant and heat-resistant thermoplastic.
 - .4 Oversized silver-alloy contacts.
 - .5 Heavy-duty, brass alloy, one-piece contact arm.
 - .6 Impact- and chemical-resistant cover.
 - .7 Auto-ground clip.
 - .8 Glass-reinforced, chemical-resistant thermoplastic back body.
 - .9 Locking support provides resistance to face and back body separation.
 - .10 Side and external screw-pressure plate back wire with #14 to #10 AWG copper or copper-clad wire.
 - .11 Grounding terminal with screw-pressure-plate back wire.
- .15 Hazardous Locations:
 - .1 Explosion proof receptacles, suitable for Class 1 Division 2 applications, unless otherwise noted.
 - .2 Prior to ordering, review classification requirements with Consultant.
 - .3 Coordinate receptacle requirements ensuring compatibility with plugs and connected equipment.

2.05 COVER PLATES (FACEPLATES) FOR WIRING DEVICES

- .1 In accordance with CSA C22.2 No. 42.1.

- .2 Type 302/304 stainless steel faceplates.
- .3 High impact strength and flame-resistant wall plates of nylon or thermoplastic construction, minimum thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.
- .4 Galvanized sheet steel utility box cover for wiring devices installed in recessed and surface-mounted electrical utility boxes. Sizes suiting box sizes and specific surface and recessed mounting applications.
- .5 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .6 Single gang, AC toggle switch weatherproof plate, flexile silicone rubber or neoprene bubble.
- .7 Weatherproof-in-use, double lift spring-loaded, cast aluminum cover plates, with gaskets for duplex regular or GFCI type receptacles. Horizontal or vertical mounting as indicated.
- .8 Weatherproof-in-use, spring-loaded cast aluminum cover plates with gaskets for single receptacles or switches. Horizontal or vertical mounting as noted.
- .9 Provide cover plates from same manufacturer as wiring devices, unless otherwise noted.

2.06 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Wiring Devices:
 - .1 Hubbell.
 - .2 Eaton (Cooper-Arrow Hart).
 - .3 Legrand (P&S).
 - .4 Leviton.

3. Execution

3.01 INSTALLATION OF WIRING DEVICES

- .1 Provide devices of types based on drawings and Specifications.
- .2 Refer to drawings to determine flush or surface mounting requirements. Unless otherwise noted, flush mount devices in finished areas.
- .3 Install in electrical outlet boxes. Size electrical boxes suiting device requirements, ganging requirements and in accordance with device manufacturer recommendations.
- .4 Ground device to box and grounding system.
- .5 Prior to start of Work, confirm finishes and mounting heights with Consultant.
- .6 Submit sample board with samples of each type of device and finishes.
- .7 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.
 - .3 Mount toggle switches at height as indicated or in accordance with Section 26 05 00 - Common Work Results for Electrical and reviewed with Consultant.

- .4 Switches connected to essential (emergency) power circuits, are illuminated toggle type.
- .5 Install switches located adjacent to doors on strike side of door. Review door swing requirements on architectural drawings, not on electrical drawings.
- .6 Coordinate installation of door switches with trades responsible for provision of doors and frames.
- .7 Locate switches to provide optimum operation of switch to door position.
- .8 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height as indicated or in accordance with Section 26 05 00 - Common Work Results for Electrical, and as reviewed with Consultant.
 - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
 - .4 Install GFCI-type receptacles as noted in locations and in locations in accordance with electrical code.
 - .5 Install tamper-resistant type receptacles as noted in locations and in locations in accordance with electrical code.
 - .6 Install USB charger receptacles in extra deep boxes in accordance with manufacturer recommendations.
 - .7 Install plug load-controlled receptacles and connect lighting control components as coordinated with Section 26 09 23 - Lighting Control Devices. Circuit split controlled receptacles in accordance with electrical code requirements.
 - .8 Provide typed label identifying circuit number and panelboard from where each device is fed, permanently identified at outlets. Review location for identification with Consultant.
 - .9 For receptacles installed in counters and benches, provide box cut-out in counter and bench. Provide box, receptacle, plate and branch circuit wiring. Provide flexible armoured cable, in accordance with electrical code and connect devices.
- .9 Cover Plates (Faceplates):
 - .1 Provide each device with cover plate or faceplate with opening or openings suitable for device it conceals and covers openings around boxes. Secure faceplates to device frames with screws to match faceplates. Provide larger than standard type faceplates for devices that require engraved nomenclature to define special purpose for that device.
 - .2 Install weather-proof in-use type cover plates for receptacle devices in non-climate-controlled areas.
 - .3 Install common cover plates where wiring devices are grouped.
 - .4 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
- .10 Ground and bond devices.

3.02 IDENTIFICATION AND SIGNAGE

- .1 Provide products with engraved lamicoid nameplates.
- .2 Prior to ordering of labels and nameplates, review locations and nomenclature with Consultant.

- .3 Provide faceplates with identification labels for devices. In addition to identification requirements specified with devices, provide faceplates with printed self-adhesive label on inside faces and to wall under faceplate, identifying circuit number and panel feeding device. Apply layer of clear coat finish over each label. Provide labels with heavy-duty and water-resistant adhesive.
- .4 Provide engraved lamicoid nameplate to identify equipment, system being operated, circuit number and panel feeding device.
- .5 Provide signage identifying special instructions.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing and Verification:
 - .1 Inspect, start-up, test and verify products.
 - .2 Check connections and operations.
 - .3 Test wiring devices for polarities and verifying operations are in accordance with manufacturer specifications.
 - .4 Coordinate testing with requirements of Section 26 05 70 - Electrical Testing.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 248.1-[11(R2020)], Low-Voltage Fuses - Part 1: General Requirements (Tri-national Standard, with UL 248-1 and NMX-J-009/248/1-ANCE).
 - .2 CSA C22.2 No. 248.2-[00(R2019)], Low-Voltage Fuses - Part 2: Class C Fuses (Tri-national Standard, with UL 248-2, Second Edition, and First Edition of NMX-J-009/248/2-2000-ANCE).
 - .3 CSA C22.2 No. 248.8-[11(R2020)], Low-voltage fuses - Part 8: Class J Fuses (Tri-national Standard, with UL 248-8 and NMX-J-009/248/8-ANCE).
 - .4 CSA C22.2 No. 248.10-[11(R2020)], Low-voltage fuses - Part 10: Class L fuses (Tri-national standard, with UL 248-10 and NMX-J-009/248/10-ANCE).
 - .5 CSA C22.2 No. 248.12-[11(R2020)], Low-voltage fuses - Part 12: Class R Fuses (Tri-national Standard, with UL 248-12 and NMX-J-009/248/12-ANCE).

1.02 SUBMITTALS

- .1 Product Data
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings
 - .1 Submit shop drawings for products of this Section.
- .3 Submit inspection and verification reports.

1.03 EXTRA MATERIALS

- .1 Provide three spare fuses of each type and size installed above 600 A.
- .2 Provide six spare fuses of each type and size installed up to and including 600 A.

2. Products

2.01 FUSES - GENERAL

- .1 Fuse type references L1, L2, J1, and others, are adopted for use in this specification. Refer to drawings for additional information.
- .2 Fuses: Product of one manufacturer throughout project.
- .3 Plug and Standard Cartridge Fuses: In accordance with CSA C22.2 No. 248.1.

2.02 FUSE TYPES

- .1 Class L Fuses:
 - .1 For fuses over 600 A.

- .2 In accordance with CSA C22.2 No. 248.10.
- .3 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
- .4 Type L2, fast acting.
- .2 Class J Fuses:
 - .1 For fuses up to and including 600 A and other high inrush circuits.
 - .2 In accordance with CSA C22.2 No. 248.8.
 - .3 For constantly running equipment.
 - .4 Type AJT, time delay, capable of carrying 500% of its rated current for 10 s minimum. For use in motor control centres and motor starters.
 - .5 Type J2, fast acting.
- .3 Class R Fuses:
 - .1 For high degree of current-limitation and short-circuit interrupting rating.
 - .2 In accordance with CSA C22.2 No. 248.12.
 - .3 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, in accordance with requirements of UL Class RK1 maximum let-through limits.
 - .4 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .5 Type R3, (UL Class RK1), fast acting Class R, in accordance with requirements of UL Class RK1 maximum let-through limits.
- .4 Class C Fuses:
 - .1 Feature ceramic bodies and bolt-in mounting.
 - .2 For short-circuit protection only, not for overload protection.
 - .3 For motorized equipment that cycles ON and OFF.
 - .4 In accordance with CSA C22.2 No. 248.2.

2.03 FUSE STORAGE CABINETS

- .1 Features:
 - .1 Manufactured from 2.0 mm thick aluminum, 750 mm high, 600 mm wide, 300 mm deep.
 - .2 With hinged, lockable front access door.
 - .3 Finish: Enamel paint as reviewed with Consultant.

2.04 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Fuses:
 - .1 Mersen (Ferraz Shawmut).
 - .2 English Electric.
 - .3 Noram.
 - .4 Eaton (Cooper Bussmann).

3. Execution

3.01 INSTALLATION

- .1 Provide Type and Sizes of Fuses:
 - .1 As noted.
 - .2 Suiting applications in accordance with AHJ and electrical codes.
 - .3 In coordination with respective equipment manufacturer recommendations in which fuses are installed.
- .2 Before energizing circuit, install fuses in mounting devices.
- .3 Install rejection clips for Class R fuses.
- .4 Install correct fuses are fitted to assigned electrical circuit.
- .5 Fuses for use in motor control centres and motor starters: Class "J" type, dual element, time delay type, unless otherwise noted.
- .6 Where UL Class RK1 fuses are specified, install warning label "USE ONLY UL CLASS RK1 FUSES FOR REPLACEMENT" on equipment.
- .7 Install spare fuses in fuse storage cabinet. Review quantity of fuses and locations of cabinets with Consultant.

3.02 FIELD QUALITY CONTROL

- .1 Inspect and verify fuses for correct types, quantities, sizes and ratings.
- .2 Prepare inspection and verification reports, signed by technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.1-[24], Canadian Electrical Code, Part I (26th Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No. 5-[16(R2021)], Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures (Tri-national standard with UL 489 and NMX-J-266-ANCE-2016).
 - .3 CSA C22.2 No. 144.1-[16(R2020)], Ground-Fault Circuit-Interrupters (Tri-National standard, with UL 943 and NMX-J-520-ANCE).
 - .4 CSA C22.2 No. 270-[16(R2021)], Arc Fault Protective Devices.
- .2 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE Standard C37.2-[2022], IEEE Standard for Electrical Power System Device Function Numbers, Acronyms, and Contact Designations.
 - .2 IEEE C37.13-[2015], IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
 - .3 IEEE C37.16-[2009], IEEE Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers.
 - .4 IEEE C37.17-[2012], IEEE Standard for Trip Systems for Low-Voltage (1000 V and below) AC and General Purpose (1500 V and below) DC Power Circuit Breakers.
- .3 Underwriters Laboratories (UL):
 - .1 ANSI/UL 489-[2019], Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - .2 ANSI/UL 1066-[2022], Power Circuit Breakers up to 1000 V AC and 1500 V DC Used in Enclosures.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Submit time-current phase protection co-ordination characteristic curves for breakers sized greater than 225 A.
 - .3 Identify:
 - .1 Types and ratings.
 - .2 Trip units and functions/settings.
- .3 Submit testing and verification reports.

2. Products

2.01 GENERAL

- .1 Breakers:
 - .1 Unless otherwise noted, to be NEMA rated types.
 - .2 Switchboards and Distribution Panelboards:
 - .1 Breakers when frame sized greater than 225 amperes, or where scheduled or where noted, provide with solid state adjustable trip units with long time, short time and instantaneous time (LSI) functions and time delays.
 - .2 Set trip units at ratings in accordance with coordination study as required for proper selective coordination.
 - .3 Unless otherwise noted, provide ground fault alarm and trip functions at breaker trip unit rating above 600 A, and set as coordinated with results of coordination study and as reviewed with Consultant.
 - .4 For coordination study requirements, refer to Section 26 05 73 - Power System Studies.
 - .3 Shock and Arc Flash Protection:
 - .1 For breakers sized equal to and greater than 1200 A, provide arc flash energy-reducing maintenance switching with positive feedback status indication in accordance with CSA C22.1.

2.02 POWER AIR CIRCUIT BREAKERS

- .1 Standards: In accordance with IEEE C37.13, IEEE C37.16, IEEE C37.17 and ANSI/UL 1066.
- .2 Type and Ratings:
 - .1 Draw Out or Fixed Types, 3-pole Units, 600 V Class: As noted.
 - .2 Continuous Current Rating: As noted.
 - .3 Trip Rating: As noted.
 - .4 Interrupting Rating: As noted.
 - .5 UL listed for application of 100% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.
- .3 General Features:
 - .1 Electrically operated, with normal stored energy, closing mechanism providing quick-make operation for ratings.
 - .2 No external source of power is necessary to trip breaker in event of fault or overload. Necessary tripping energy derived from monitoring current transformers provided with breaker.
 - .3 Motor charged, stored energy, quick-make, closing mechanism with emergency manual spring charging handle and isolating switch, isolating power supply to spring charging motor. Manual closing lever permits closing circuit breaker with compartment door closed.
 - .4 Breaker control interface includes colour-coded visual indicators indicating contact open or closed positions as well as mechanism charged and discharged positions.

- .5 120 V fused secondary control circuit transformer for breaker closing and tripping current.
 - .6 Electrically operated breaker pushbuttons, manual trip button, breaker position indicators, breaker 'open/close' lamps, "push to test" lights and provisions for padlocking breaker in open position and also secures breaker in connected, test, or disconnected position by preventing levering.
 - .7 Circuit breaker door design allow performing following functions without need to open circuit breaker door:
 - .1 Lever circuit breaker between positions.
 - .2 Operate manual charging system.
 - .3 Close and open circuit breaker.
 - .4 Examine and adjust trip unit.
 - .5 Read circuit breaker rating nameplate.
 - .8 Safety cover to prevent inadvertent operation of breaker open operators.
 - .9 Solid state adjustable tripping units.
 - .10 Engraved identification lamacoid nameplates.
- .4 Drawout Type Power Air Circuit Breakers:
- .1 Electrically operated, stored energy, draw-out breaker assembly.
 - .2 Mounted behind full-sized flanged type heavy gauge steel panel with heavy-duty finger type ground contacts, wheels for mounting on rails in cell.
 - .3 Mechanical interlock prevents moving unit into or out of connected position while breaker assembly is closed.
 - .4 Padlocking provisions prevent levering of breaker, which is capable of securing breaker in connected, test or disconnected positions.
 - .5 Secondary disconnecting devices consist of plug-in connectors mounted on removable unit and engaging floating plug-in connectors at front of compartment. Secondary disconnecting devices of pin and socket contact engagement, maintained in "connected" and "test" positions.
 - .6 Draw-out contacts consist of set of contact fingers suitably spaced on breaker studs. In connected position these contact fingers engage stationary contacts forming current carrying bridge.
 - .7 Silver plated secondary disconnecting devices consist of floating fingers mounted on removable units engaging flat contact segments located at rear of compartment. Each breaker includes four positions consisting of connected, test, disconnected, and removed. Breaker draw-out element contains worm gear levering "in" and "out" mechanism with removable lever crank.
 - .8 Equipped with connection terminals suitable for connections suiting intended applications. Draw-out cradle includes primary and control wiring disconnects.
 - .9 Control wiring for connections to breakers run outside of breaker cell to greatest extent possible and where run within breaker cubicle, wiring bundled and mechanically secured away from breaker and draw-out mechanisms.
 - .10 Integral lifting handles on sides of breakers.
 - .11 Breaker cells equipped with draw-out rails and primary and secondary disconnecting contacts.
- .5 Fixed Mounted Type Power Air Circuit Breakers:
- .1 Electrically operated, stored energy, fixed mounted breaker assembly.

- .2 Mounted behind full-sized flanged type heavy gauge steel panel.
- .3 Equipped with connection terminals suitable for connections suiting intended applications.
- .6 Solid State Tripping Units:
 - .1 Integral microprocessor based true RMS sensing, solid state tripping unit having adjustable tripping functions including:
 - .1 Long time pick-up and long-time delay.
 - .2 Short time pick-up and short time delay.
 - .3 Instantaneous pick-up.
 - .4 Ground fault pick-up and ground fault delay.
 - .2 Trip Settings: As determined by distribution system coordination studies specified in Section 26 05 73 - Power System Studies and reviewed with Consultant. Include for trip unit settings in accordance with results of coordination studies, providing coordinated protective devices throughout electrical distribution system.
 - .3 Three sensors, one on each phase conductor, arranged such that trip signal from sensor opens three poles of breaker.
 - .4 LED indication of mode and trip and LCD panel indicating protection function settings and system data. Unit is continuously self-checking and monitoring.
 - .5 Complete system selective coordination provided with individually adjustable time/current shaping solid-state elements.
 - .6 High load alarm provided, fixed at 85% of long delay pickup setting.
 - .7 Energy monitoring and display of peak demand, present demand and energy consumption.
 - .8 Collect and store pertinent information to trip unit and circuit breaker health and event history, and breaker diagnostics.
 - .9 Test plug terminals to permit convenient field checking of calibration.
 - .10 Actuator mechanically trips breaker when tripping pulse is emitted by trip unit.
- .7 Current Limiting Breakers with Fuses:
 - .1 For applications reducing peak apparent fault current of breaker, to lesser value and isolate fault in less than half cycle time.
 - .2 Interrupting capacity rating of breakers provided without current limiting fuses.
 - .3 Current limiting fuses in series and internally mounted in breakers.
 - .4 Anti-single-phasing coils act on tripper bar in parallel with current limiting fuses to prevent single phasing.
 - .5 Time current limiting characteristics of fuses coordinated with time current tripping characteristics of circuit breaker.
- .8 Accessories:
 - .1 Shunt trip operators.
 - .2 Auxiliary switches.
 - .3 Undervoltage tripping device with instantaneous and time delay.
 - .4 Alarm switch.
 - .5 Reverse power relay.
 - .6 Key interlock.
 - .7 Remote close.

- .8 Operation counter.
- .9 Hinged and lockable clear polycarbonate bubble cover, for tamper provisions and activated sprinkler protection, over front of breaker.
- .10 Three spare fuses of each type and size used. Control fuses of form II HRC types.
- .11 External remote racking unit for drawout breakers.
- .12 Engraved identification lamicoid nameplates.

2.03 INSULATED CASE CIRCUIT BREAKERS

- .1 In accordance with CSA C22.2 No. 5 and ANSI/UL 489.
- .2 Type and Ratings:
 - .1 Draw Out or Fixed Types, 3-pole Units, 600 V Class: As noted.
 - .2 Continuous Current Rating: As noted.
 - .3 Trip Rating: As noted.
 - .4 Interrupting Rating: As noted.
 - .5 UL listed for application of 100% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.
- .3 General Features:
 - .1 Electrically or manually operated as noted, with normal stored energy, closing mechanism providing quick-make operation for ratings.
 - .2 30-cycle short-time withstand capability equal to their symmetrical interrupting ratings through 42,000 amperes, regardless of whether equipped with instantaneous trip protection or not.
 - .3 Closing time of not more than 3 cycles.
 - .4 Electrically Operated Breakers:
 - .1 With close/open pushbuttons or control switches.
 - .2 Motor operators:
 - .1 Charging time of motor not to exceed 6 seconds.
 - .2 Control power transformer internal to switchgear assembly.
 - .5 Breaker control interface includes colour-coded visual indicators indicating contact open or closed positions as well as mechanism charged and discharged positions.
 - .6 Manual control pushbuttons on breaker face provides for opening and closing breaker.
 - .7 "Positive On" feature with breaker flag reading "Closed" when contacts are welded, and breaker is attempting to be tripped or opened.
 - .8 Pad-lockable pushbutton covers.
 - .9 Draw-out Features:
 - .1 Breaker cells equipped with draw-out rails and primary and secondary disconnecting contacts.
 - .2 Flag position indicator located on faceplate of breaker, providing colour indication of breaker position in cell as follows:
 - .1 Connect: Red.
 - .2 Test: Yellow.
 - .3 Disconnect: Green.

- .3 When in disconnect position, closing compartment door possible. The levering door interlocked so that when breaker is in closed position, breaker levering-in door does not open. Mechanical interlocking provided so that breaker is in tripped position before levering "in" or "out" of cell.
- .4 Key locking open to prevent manual or electric closing. Padlocking secures breaker in connected, test or disconnected position by preventing levering.
- .5 Secondary disconnecting devices consist of plug-in connectors mounted on removable unit and engaging floating plug-in connectors at front of compartment. Secondary disconnecting device pin and socket contact engagement maintained in "connected" and "test" positions.
- .6 Integral lifting handles on side of breakers.
- .10 Solid state adjustable tripping units.
- .11 Engraved identification lamacoid nameplates.
- .4 Solid State Tripping Units:
 - .1 Integral microprocessor based true RMS sensing, solid state tripping unit having adjustable tripping functions including:
 - .1 Long time pick-up and long-time delay.
 - .2 Short time pick-up and short time delay.
 - .3 Instantaneous pick-up.
 - .4 Ground fault pick-up and ground fault delay.
 - .2 Trip Settings: As determined by distribution system coordination studies specified in Section 26 05 73 - Power System Studies and reviewed with Consultant. Include for trip unit settings in accordance with results of coordination studies, providing coordinated protective devices throughout electrical distribution system.
 - .3 Three sensors, one on each phase conductor, arranged such that trip signal from sensor opens three poles of breaker.
 - .4 LED indication of mode and trip and LCD panel indicating protection function settings and system data. Unit is continuously self-checking and monitoring.
 - .5 Complete system selective coordination provided with individually adjustable time/current shaping solid-state elements.
 - .6 High load alarm provided, fixed at 85% of long delay pickup setting.
 - .7 Energy monitoring and display of peak demand, present demand and energy consumption.
 - .8 Collect and store pertinent information to trip unit and circuit breaker health and event history, and breaker diagnostics.
 - .9 Test plug terminals to permit convenient field checking of calibration.
 - .10 Actuator mechanically trips breaker when tripping pulse is emitted by trip unit.
- .5 Current Limiting Breakers with Fuses:
 - .1 For applications reducing peak apparent fault current of breaker, to lesser value and isolate fault in less than half cycle time.
 - .2 Interrupting capacity rating of breakers provided without current limiting fuses.
 - .3 Current limiting fuses in series and internally mounted in breakers.
 - .4 Anti-single-phasing coils act on tripper bar in parallel with current limiting fuses to prevent single phasing.

- .5 Time current limiting characteristics of fuses coordinated with time current tripping characteristics of circuit breaker.
- .6 Accessories:
 - .1 Shunt trip operators.
 - .2 Auxiliary switches.
 - .3 Undervoltage tripping device with instantaneous and time delay.
 - .4 Alarm switch.
 - .5 Reverse power relay.
 - .6 Key interlock.
 - .7 Remote close.
 - .8 Operation counter.
 - .9 Hinged and lockable clear polycarbonate bubble cover, for tamper provisions and activated sprinkler protection, over front of breaker.
 - .10 Three spare fuses of each type and size used. Control fuses of form II HRC types.
 - .11 External remote racking unit for drawout breakers.
 - .12 Engraved identification lamicoid nameplates.

2.04 SOLID STATE MOULDED CASE CIRCUIT BREAKERS

- .1 In accordance with CSA C22.2 No. 5 and ANSI/UL 489.
- .2 Circuit Breaker Types, Sizing and Ratings: As noted.
- .3 Features:
 - .1 Fixed mounted, solid state moulded case circuit breaker with minimum interrupting capacity as noted.
 - .2 Where noted, ULC listed for application of 100% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.
 - .3 Bolt-on, quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
 - .4 Common-trip breakers equipped with single handle for multi-pole applications.
 - .5 Magnetic instantaneous trip elements in circuit breakers operate only when value of current reaches setting.
 - .6 Trip settings on breakers with adjustable trips ranging from 3 to 8 times current rating.
 - .7 Circuit breakers with interchangeable trips as indicated or scheduled.
- .4 Solid State Tripping Units:
 - .1 Equipped on breakers of frame size greater than 225 amperes. Breakers operate by means of solid-state adjustable trip unit with associated current monitors and self-powered shunt trip units.
 - .2 Adjustable Tripping Functions: Long time pick-up, long time delay; short time pick-up; short time delay; instantaneous pick-up; ground fault pick-up; and ground fault delay.
 - .3 Three sensors, one on each phase conductor, arranged such that trip signal from sensor opens all three poles of breaker.

- .4 Provide functions and settings, suiting project specific short circuit and coordination studies in accordance with Section 26 05 73 - Power System Studies and reviewed with Consultant.
- .5 Accessories:
 - .1 Shunt trip.
 - .2 Auxiliary switch.
 - .3 Motor-operated mechanism time delay unit.
 - .4 Under-voltage release.
 - .5 On-off locking device.
 - .6 Handle mechanism.
 - .7 Engraved identification lamicoid nameplates except for branch circuit panelboard breakers.

2.05 THERMAL MAGNETIC BREAKERS

- .1 In accordance with CSA C22.2 No. 5 and ANSI/UL 489.
- .2 Circuit Breaker Types, Sizing and Ratings: As noted.
- .3 Moulded case circuit breakers operate automatically by means of thermal and magnetic tripping devices, providing inverse time current tripping and instantaneous tripping for short circuit protection.

2.06 MAGNETIC BREAKERS

- .1 In accordance with CSA C22.2 No. 5 and ANSI/UL 489.
- .2 Circuit Breaker Types, Sizing and Ratings: As noted.
- .3 Moulded case circuit breakers operate automatically by means of magnetic tripping devices, providing instantaneous tripping for short circuit protection.

2.07 CURRENT LIMITING AND SERIES RATED THERMAL MAGNETIC BREAKERS

- .1 In accordance with CSA C22.2 No. 5 and ANSI/UL 489.
- .2 Circuit Breaker Types, Sizing and Ratings: As noted.
- .3 Thermal magnetic breakers with current limiters.
- .4 Time current limiting characteristics of fuses limiters coordinated with time current tripping characteristics of circuit breaker.
- .5 Co-ordination to result in interruption by breaker of fault-level currents up to interrupting capacity of breaker.
- .6 Provide breakers for applications in accordance with manufacturer guidelines and accepted best practice.

2.08 BREAKER TYPE GROUND FAULT INTERRUPTERS

- .1 Single and two-poles, as noted, suiting intended applications, ground fault circuit interrupters for panelboard circuits, for 15/20 A, 120 V, 1-phase circuits.
- .2 In accordance with CSA C22.2 No. 5, ANSI/UL 489 and CSA C22.2 No. 144.1.
- .3 GF Protection: 5 mA.
- .4 Interrupt Rating: 22 kAIC unless otherwise noted.

- .5 Overvoltage protection
- .6 Continuous self-test of electronic components with test and reset facilities.
- .7 Coiled pigtail suiting intended applications.
- .8 Manufacturer: Same as panelboard and other breakers in panelboard.

2.09 ARC FAULT CIRCUIT INTERRUPTER BREAKERS

- .1 Single and two-poles, as noted, suiting intended applications, ground fault circuit interrupters for panelboard circuits, for 15/20 A, 120 V, 1-phase circuits.
- .2 In accordance with CSA C22.2 No. 5, ANSI/UL 489 and CSA C22.2 No. 270.
- .3 Interrupt Rating: 22 kAIC unless otherwise noted.
- .4 Overvoltage protection.
- .5 Continuous self-test of electronic components with test and reset facilities.
- .6 Coiled pigtail suiting intended applications.
- .7 Manufacturer: Same as panelboard and other breakers in panelboard.

2.10 ENCLOSURES FOR MOULDED CIRCUIT BREAKERS

- .1 Individually mounted moulded case breaker enclosures:
 - .1 CSA certified.
 - .2 Front operated.
 - .3 Surface or flush wall-mounted, as noted.
 - .4 Automatic or non-automatic breaker, as noted.
 - .5 Climate-controlled areas: Enamel finished steel, NEMA 2.
 - .6 Non-climate-controlled areas: Weather-resistant, corrosion resistant enamel finished steel, NEMA 4, with gasketing.
 - .7 Circuit breaker can be padlocked in OFF position.
 - .8 Cover interlocked such that cover cannot be opened when breaker is in ON position.

2.11 SHUNT TRIP BREAKERS

- .1 Basic features of respective type of breakers but with shunt trip functions of either:
 - .1 Manual Operation: Connection to remote button to manually open breaker.
 - .2 Automatic Operation: When breaker detects surge from external power source, automatically opens breaker.

2.12 ADDITIONAL DEVICES FOR EXISTING EQUIPMENT

- .1 Additional breakers and switch and fuses assemblies for existing panelboards or switchboards, match existing device standards and are compatible to board in which they are installed. Provide product types from manufacturers of existing equipment.
- .2 Check requirements of existing equipment onsite, verifying that additional devices can be accommodated. Make modifications to equipment to accommodate device and feeder installation.
- .3 Provide engraved lamicoid identification nameplate on additional components. Provide revised typed circuit directory cards on branch circuit panelboards.

- .4 Mount additional devices to standards of existing equipment manufacturer. Refer to notes on drawings.

2.13 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Unless otherwise noted, breakers to be same manufacturer as panelboard/switchboard/distribution equipment in which they are installed.
- .2 Breakers and Enclosures:
 - .1 Eaton.
 - .2 Schneider.
 - .3 Siemens.

3. Execution

3.01 INSTALLATION OF BREAKERS

- .1 Unless otherwise noted, provide breakers factory installed in switchgear, switchboards and panelboards. Provide other breakers where noted as installed onsite in equipment.
- .2 Install and connect breakers for circuits as noted, in accordance with manufacturer instructions.
- .3 Set and adjust trip settings in accordance with final reviewed coordination study settings.

3.02 INSTALLATION OF ENCLOSED CIRCUIT BREAKERS

- .1 Provide wall-mounted, enclosed circuit breakers for equipment, of type and operation as noted and suiting intended applications. Include accessories. Secure to wall construction and connect complete.
- .2 Prior to roughing-in, review locations with Consultant.
- .3 Ground and bond equipment.

3.03 IDENTIFICATION

- .1 Provide product identification.
- .2 Nameplates:
 - .1 Enclosures: Size 4 unless otherwise noted.
 - .2 Power air circuit breaker: Size 4 unless otherwise noted.
 - .3 Moulded Case Circuit Breakers: Refer to Section 26 24 16 - Panelboards.

3.04 FIELD QUALITY CONTROL

- .1 Inspection, Testing and Verification:
 - .1 Inspect, start-up, test and verify products.
 - .2 Check connections and operations.
 - .3 Perform following in accordance with breaker manufacturer recommendations:
 - .1 Inspect and test motor operators.
 - .2 Breakers of size greater than 250 A: Insulation/contact resistance and secondary current injection testing of electronic trip units.

- .3 Power Air Circuit Breakers: Where current transformers are externally connected to breakers, additionally perform primary current injection testing to verify current transformers are correct and wired properly.
- .4 Secondary Current Injection Testing: Verifies correct operation of protection system such as protective relays and their tripping settings, and associated circuits and devices.
- .5 Primary Current Injection Testing: After secondary injection testing, further testing current transformer and potential transformer ratios, polarity and phasing.
- .4 Inspect, set and test adjustable breakers, interlocked breakers and motorized breakers for proper operations.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 144.1-[16(R2020)], Ground-Fault Circuit-Interruption (Tri-National standard, with UL 943 and NMJ-J-520-ANCE).
- .2 Underwriter Laboratories (UL):
 - .1 UL 508A-[2018], Industrial Control Panels.
 - .2 UL 943-[2016], Ground-Fault Circuit-Interruption.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Identify ratings including sensitivity ratings to ground faults.
- .3 Submit of testing and verification reports.

2. Products

2.01 GENERAL

- .1 Standards: In accordance with CSA C22.2 No. 144.1.
- .2 Provide ground fault protection equipment components from same manufacturer throughout project.
- .3 Provide ground fault protection on:
 - .1 Services and conductors as noted.
 - .2 1000 A, 600 V, 4-wire, 3-phase service, and 2000 A, 208 V, 4-wire, 3-phase service and above.
- .4 Ground Fault Unit Features:
 - .1 Ground fault sensing relay suiting operation at 500 mA and of control voltage 120 V, unless otherwise noted.
 - .2 Three position sensitivity control switch to select value of leakage current at which relay will operate.
 - .3 Switches:
 - .1 SPDT contacts for alarm, and where noted for trip.
 - .2 Mechanical target indication.
 - .3 Manual reset.

- .4 Reset button for contacts and target.
- .5 Data logging module providing time and date stamping of up to 99 most recent events (non-volatile memory).
- .6 Include following for ungrounded or high resistance grounded systems only:
 - .1 Ammeter with scale 0 to 5 A indicating ground current value.
 - .2 Indicating lamp illuminated when no ground fault exists, extinguished on ground fault or test.
- .7 Auxiliary contacts for remote alarm connections to BAS as coordinated with Division 25 BAS.
- .8 Provisions for panel-mounting, coordinated with switchboard or panel in which it is installed.
- .9 Minimum NEMA 2 unless otherwise noted rated indoor enclosure with drip shield and gasketing.
- .5 Zero Sequence Transformers:
 - .1 Toroidal type for cable installations.
 - .2 Rectangular for bus installations.
 - .3 Split type on existing installations.
 - .4 300 to 3000 mA range.
- .6 Neutrals:
 - .1 Delta ungrounded systems: Artificial neutral and grounding resistor.
 - .2 High resistance grounded wye systems: Neutral ground resistor unit.
- .7 System operates instantaneously at ground current setting, unless otherwise noted. Review with Consultant.
- .8 Provide following components to interconnect to ground fault protection devices in equipment specified in other Sections and as noted:
 - .1 Zero sequence transformers.
 - .2 Ground fault relays.
 - .3 Ground resistor units.

2.02 GROUND FAULT PROTECTION PANELS

- .1 CSA certified, or ULC listed and labeled protection panels to detect ground-leakage current and interrupt supply when levels exceed setting.
- .2 Current Ratings: 20 A, 60 A or 100A.
- .3 Trip Types:
 - .1 Fixed 6 mA AC/DC inverse-time curve in accordance with UL 943.
 - .2 Adjustable 10 to 500 mA AC/DC, adjustable 0 to 10 s definite time.
- .4 Short-Circuit Current Rating (SCCR): 5 kA.
- .5 Features:
 - .1 In accordance with UL 508.
 - .2 Self-contained panels.
 - .3 For solidly grounded and resistance-grounded systems, as noted for specific applications.

- .4 Rated for use up to 600 V, and for single-phase and three-phase AC circuits.
- .5 Works on circuits with DC components and systems with variable-speed drives.
- .6 Inverse-time trip characteristic helps prevent nuisance trips with faster trip on higher current. (25 ms response at 250 mA).
- .7 Filtering avoids nuisance tripping from harmonic noise.
- .8 Factory set or adjustable trip level and time settings, suiting intended applications.
- .9 On and Trip indication.
- .10 Test and Reset pushbuttons.
- .11 Type 4X enclosed models:
 - .1 Standard polycarbonate construction.
 - .2 Stainless steel construction for harsh environments.

2.03 GROUND FAULT AND GROUND CONTINUITY PROTECTION PANELS

- .1 CSA certified, or ULC listed and labeled protection panels to detect ground-leakage current, monitor ground continuity and interrupt power supply to protect equipment. Unit designed to interrupt power to circuit when either ground fault or open ground is detected.
- .2 Features:
 - .1 In accordance with UL 508.
 - .2 Universal voltage selection of common voltages from 120 VAC to 600 VAC.
 - .3 6 mA ground fault trip level.
 - .4 Inverse time curve for interrupting circuit on ground fault.
 - .5 Open ground detection.
 - .6 Adjustable ground integrity alarm point between 0.1 Ω to 100 Ω .
 - .7 NEMA 4/12 rated enclosure.
 - .8 External test and reset buttons.
 - .9 External LED indication for power and ground fault and ground continuity alarms.
 - .10 Internal real-time indications of ground fault current and ground integrity via digital displays.
 - .11 Operating temperatures: Minus 35°C to 55°C.
 - .12 Enclosures: NEMA 4 rated, polycarbonate construction.

2.04 GROUND FAULT PROTECTOR UNITS

- .1 GF protector units provide ground fault protection to equipment (GFPE). Units connect to overload breakers in panelboards and load centers. GF protector units provide ground fault protection to circuits while overload breakers protect wiring.
- .2 Features:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 Interconnects and works with overload circuit breakers.
 - .3 Provides 30 mA trip point GFPE protection.
 - .4 In accordance with requirements of CEC 62-300.
 - .5 Protects 120/208/240VAC systems up to 60A.
 - .6 NEMA 4X enclosure for indoor or outdoor use.
 - .7 Latching, gasketed-sealed, hinged front cover for easy testing and reset access.

- .8 Operating temperatures: Minus 40°C to 60°C.

2.05 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Ground Fault Protection Equipment:
 - .1 Schneider.
 - .2 Eaton.
 - .3 I-Gard.
 - .4 Bender.
- .2 Ground Fault Protector Units:
 - .1 Equivalent to Pro Them Industries.

3. Execution

3.01 INSTALLATION OF GROUND FAULT PROTECTION EQUIPMENT

- .1 Provide ground fault protection equipment for applications as noted, including applications in accordance with electrical code.
- .2 Install products in accordance with manufacturer instructions, suiting intended applications.
- .3 Provide system components and sequence of operations as reviewed with Consultant. Where system detects ground fault and sequence of operation requires tripping and opening of specific breakers, provide shunt trip type breakers.
- .4 Do not ground neutral on load side of sensor or ground fault relay.
- .5 Install phase conductors including neutral through zero-sequence transformer.
- .6 Connect supply and load wiring to equipment.
- .7 Make connections as noted and in accordance with manufacturer recommendations.
- .8 Provide alarm and communications circuits. Integrate equipment to BAS. Extend wiring in conduit to interconnection terminal cabinet. Provide wiring in conduit from cabinet to respective BAS panel serving area. Make connections. Coordinate requirements with respective equipment vendors.
- .9 Review mounting arrangements and finishes with Consultant.
- .10 Shunt Trip Breakers and Ground Fault Circuit Interrupter Breakers: Refer to Section 26 28 17 - Low Voltage Breakers.
- .11 Ground Fault Circuit Interrupter Receptacles: Refer to Section 26 27 26 - Wiring Devices.

3.02 IDENTIFICATION

- .1 Provide product identification.
- .2 Nameplate for enclosures: Size 3 unless otherwise noted, and engraved as noted.
- .3 Identify and label breakers to standards specified for panelboard breakers.

3.03 FIELD QUALITY CONTROL

- .1 Arrange for equipment manufacturer technician to:

- .1 Perform onsite setup, adjustments, testing and verification work.
 - .2 Test ground fault equipment.
 - .3 Check trip unit settings verifying proper working operation and protection of components. Demonstrate simulated ground fault tests.
 - .4 Check and inspect completed installation including:
 - .1 System and component installations.
 - .2 Cable wiring and termination.
 - .3 NGR and enclosure ratings and installation.
 - .4 Grounding.
 - .5 Provide compliance certificates and include with reports.
- .2 Prepare testing and verification reports signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 4-[16(R2020)], Enclosed and Dead-Front Switches (Tri-National standard, with NMX-J-162-ANCE-2016 and UL 98).
 - .2 CSA C22.2 No. 39-[13(R2017)], Fuseholder Assemblies.
 - .3 CSA C22.2 No. 160-[15(R2020)], Voltage and Polarity Testers.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports.

2. Products

2.01 DISCONNECT SWITCHES

- .1 In accordance with CSA C22.2 No. 4.
- .2 Types and Ratings: As noted.
- .3 Heavy duty, CSA certified, disconnect (safety) switches. Features include:
 - .1 Front operated with handle suitable for padlocking in "OFF" position and arranged so that enclosure cover cannot be opened while handle is in "ON" position.
 - .2 ON-OFF switch position indication on switch enclosure cover.
 - .3 Operating Mechanisms: quick-break, positive acting with visible blades and line terminal shield.
 - .4 100% load break/make rated.
 - .5 Non-fusible units: As noted.
 - .6 Fusible units with fuse clips suitable for HRC fuses: As noted.
 - .7 Factory primed and painted switch enclosures.
 - .8 Factory installed neutral assembly for service entrance applications.
 - .9 Viewing windows on front cover enabling personnel to clearly see that blades are disengaged from stationary contacts when switch handle is in OFF position and include enhanced visible blades.
- .4 Fuses and Fuse Ratings: As indicated, or scheduled, and as required for specific application. Refer to Section 26 28 13 - Fuses - Low Voltage, for additional fuse requirements.

- .5 Fuse Holders: In accordance with CSA C22.2 No. 39, suitable without adaptors, for type and size of fuses.
- .6 Disconnects for Variable Speed Drives: Suitable for use with such drives and include auxiliary switch or contacts to de-energize control power circuit.

2.02 DOUBLE THROW DISCONNECT SWITCHES

- .1 In accordance with CSA C22.2 No. 4.
- .2 Types and Ratings: As noted.
- .3 Heavy duty, CSA certified, double throw disconnect switches. Features include:
 - .1 Front operated handle operating mechanism actuates either upper or lower switch. When handle is in centre position, both switches are OFF.
 - .2 Handle and door interlocked to keep door closed when switch is ON and hold handle OFF when door is open.
 - .3 Triple padlocking – 2 on door and up to 3 locks in centre OFF position.
 - .4 100% load break and make rated.
 - .5 Non-fusible units: As noted.
 - .6 Fusible units with fuse clips suitable for HRC fuses: As noted.
 - .7 Factory primed and painted switch enclosures.
- .4 Fuses and fuse ratings: As noted and suiting intended applications. Refer to Section 26 28 13 - Fuses – Low Voltage, for additional fuse requirements.
- .5 Fuse Holders: In accordance with CSA C22.2 No. 39, suitable without adaptors, for type and size of fuses.

2.03 DISCONNECT ENCLOSURES

- .1 CSA certified.
- .2 Standard Climate-controlled Areas and Non-climate-controlled Areas: Minimum NEMA 3R, unless otherwise noted.
- .3 Corrosive-environmental Applications: Minimum NEMA 4X, unless otherwise noted.

2.04 ABSENCE-OF-VOLTAGE TESTERS

- .1 Features:
 - .1 CSA certified and in accordance with CSA C22.2 No. 160.
 - .2 Factory-mounted, integral with three-phase disconnect switches.
 - .3 Provides positive indication that voltage is not present. Active indication visually conveys when absence of voltage confirmed, typically when voltage is measured below 3.0 volts.
 - .4 Powered directly from 3-phase with capacitor technology for offline power.
 - .5 Supervisory circuitry ensures proper connection of sensors to system and is continually monitored.
 - .6 Consists of:
 - .1 Control unit with sensor leads.
 - .2 Display unit with Green LED indications and TEST buttons.
 - .3 Connection cabling with connectors
 - .4 Mounting hardware.

- .5 Instruction labelling.
- .7 Operating Voltage Range: 3 to 600 VAC, 60Hz.
- .8 Operating Temperature: 0°C to 60°C.

2.05 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Disconnects:
 - .1 Eaton.
 - .2 Schneider.
 - .3 Siemens.
 - .4 ABB.
- .2 Absence-of-Voltage Testers:
 - .1 I-Gard.
 - .2 Panduit.

3. Execution

3.01 INSTALLATION

- .1 Provide disconnects switches and install into locations and connect to equipment.
- .2 Install disconnects with fuses as noted.
- .3 Install absence -of-voltage testers for disconnects as noted.
- .4 Locate disconnects in positions providing clearance for access for operation and maintenance. Install as follows:
 - .1 Wherever noted.
 - .2 Wherever required by electrical code.
 - .3 Wherever required by motor control equipment/VFD/starter schedules.
 - .4 Motorized equipment which cannot be seen from motor starter location or is more than 9 m from starter location (in accordance with electrical code requirements).
 - .5 "Packaged" equipment fed from motor starter panel.
- .5 Where double throw switches are required, connect providing operations as noted.

3.02 IDENTIFICATION

- .1 Provide product identification.
- .2 Provide on each disconnect switch, engraved lamicoid nameplate with nomenclature reviewed with Consultant.
- .3 Indicate name of load controlled on nameplate.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing and Verification:
 - .1 Inspect, start-up, test and verify products.
 - .2 Check ratings of switches, fuses and enclosures.
 - .3 Check connections and operations.

- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 14-[18(R2022)], Industrial Control Equipment.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports.

2. Products

2.01 CONTACTORS

- .1 Standards: In accordance with CSA C22.2 No. 14.
- .2 Ratings and Number of Poles: As noted and suiting intended applications.
- .3 Features:
 - .1 Contacts of silver cadmium oxide construction, unless otherwise noted.
 - .2 Electrically held controlled by pilot devices and rated for type of load controlled. Half size contactors not accepted.
 - .3 Fused switch combination contactors, suiting intended applications.
 - .4 Easy coil change and inspectable/replaceable contacts.
 - .5 Complete with 2 normally open and 2 normally closed auxiliary contacts, unless otherwise noted.
- .4 Enclosures:
 - .1 High strength, impact and temperature-resistant insulating materials.
 - .2 Factory primed and painted.
 - .3 Climate Controlled Areas: NEMA 1.
 - .4 Non-Climate-Controlled Areas: Minimum NEMA 3R.
 - .5 Covers with:
 - .1 Red indicating lamp.
 - .2 Start-Stop pushbuttons.
 - .3 Hand-Off-Auto selector switch.
- .5 Accessories:
 - .1 Auxiliary contact blocks.

- .2 Electronic timers.
- .3 Interlocks.
- .4 Interface relays.
- .5 Protective covers.
- .6 Control Transformers: In accordance with Section 26 29 03 - Control Devices.

2.02 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Contactors:
 - .1 Eaton.
 - .2 Schneider.
 - .3 Siemens.
 - .4 Rockwell Automation (Allen Bradley).
 - .5 ABB.

3. Execution

3.01 INSTALLATION

- .1 Install contactors with enclosures and connect power wiring and auxiliary control devices.
- .2 Install devices in accordance with manufacturer instructions.

3.02 IDENTIFICATION

- .1 Identify contactors with nameplates indicating name of load controlled as noted, and indicating panel and circuit number.
- .2 Equipment Nameplates: Size 4, unless otherwise noted.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Testing and Verification:
 - .1 Inspect, test and verify products.
 - .2 Verify enclosure ratings are suitable for intended applications.
 - .3 Check connections and operations.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 14-[18(2022)], Industrial Control Equipment.
- .2 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA ICS 1-[2000(R2005, R2008, R2015)], Industrial Control and Systems: General Requirements.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Identify:
 - .1 Types and ratings.
 - .2 Identification.
 - .3 Locations.
- .3 Submit testing and verification reports.

2. Products

2.01 AC CONTROL RELAYS

- .1 Standards: In accordance with CSA C22.2 No. 14 and NEMA ICS 1.
- .2 Convertible Contact Type: Contacts field convertible from NO to NC, electrically held unless otherwise noted, with solid state timer.
- .3 Sealed Contact Type: Electrically held, unless otherwise noted.
- .4 Universal Pole Type: Electrically held convertible from NO to NC by changing wiring connections.
- .5 Fixed Contact Plug-In Type: General purpose low coil current.
- .6 Socket bases and DIN mounting rails for plug-in type relays.
- .7 Coil and Contact Ratings: As noted, suiting intended applications.

2.02 SOLID STATE TIMING RELAYS

- .1 Construction: AC operated electronic timing relay with solid-state timing circuit operating output contact. Timing circuit and output contact completely encapsulated protecting against vibration, humidity and atmospheric contaminants.

- .2 Operation: ON-delay or OFF-delay, suiting intended applications.
- .3 Potentiometer: Self-contained to provide time interval adjustment.
- .4 Supply Voltage: 120 or 24 V, AC, 60 Hz, unless otherwise noted, suiting intended applications.
- .5 Temperature Range: Minus 20°C to 60°C.
- .6 Output Contact Rating: Maximum voltage 300 V AC or DC. NEMA ICS 1, and as required for intended applications.
- .7 Timing Ranges: Minimum 0.5 maximum 60 s.

2.03 INSTANTANEOUS TRIP CURRENT RELAYS

- .1 Contacts: NO and NC automatic reset with adjustable tripping point, suiting intended applications.
- .2 Control: 3-wire, with provision for shorting contacts during accelerating period of motor.
- .3 Contact Rating: NEMA ICS 1, suiting intended applications.

2.04 RELAY ACCESSORIES

- .1 Standard Contact Cartridges: Normally open, convertible to normally-closed in field.

2.05 CONTROL AND RELAY PANELS

- .1 Climate-controlled Areas: Minimum NEMA 1 unless otherwise noted, sheet steel enclosure with sprinkler protection features, including gasketing, and drip shield where surface-mounted.
- .2 With hinged padlockable access door, accommodating relays, timers, labels as noted, factory installed and wired to identified terminals.
- .3 Not used for lighting control relay panels.

2.06 OILTIGHT LIMIT SWITCHES

- .1 Heavy-duty and oil tight operators.
- .2 Plug-in modular types.
- .3 Snap Action Type:
 - .1 Roller rod or fork lever, top, side, push or wobble stick actuator.
 - .2 Enclosure for climate-controlled areas: NEMA 1, unless otherwise noted.
 - .3 Enclosure for non-climate-controlled areas: NEMA 3R, unless otherwise noted.
- .4 Satin chrome metal body and nut together with holder.
- .5 Multiple synthetic rubber seals prevent oil, water, coolants and dirt from entering unit.
- .6 Surface mounted, unless otherwise noted.
- .7 Standard contact block with six contacts.
- .8 Contact Rating: As noted, suiting intended applications.
- .9 45 degree angled wiring terminals.
- .10 Operating Temperatures: Minus 18°C to 110°C.

- .11 Illuminated with LED bulb of colour selected from manufacturer standard colours as reviewed with Consultant and suiting intended applications, or non-illuminated as noted.
- .12 Aluminum faceplate with identification lettering nomenclature suiting intended applications.

2.07 SEALED CONTACT OILTIGHT LIMIT SWITCHES

- .1 Heavy-duty and oil tight operators.
- .2 Rugged single contact, hermetically sealed in glass envelope.
- .3 Operating Temperatures: Minus 29°C to 121 °C.
- .4 Satin chrome metal body and nut together with holder.
- .5 Multiple synthetic rubber seals prevent oil, water, coolants and dirt from entering unit.
- .6 Lever Type Switches: Roller fork or rod operated, single or double pole, double throw.
- .7 Push Type Switches: Actuated by rod or plunger located on side of operating head, spring return single pole, throw.
- .8 Wobble Stick Cat Whisker Type Switches: Actuated by rod or stick extending from tip of operating head. Moving rod in any direction operates contacts. Single pole, double throw.
- .9 Lever Operated: Time delay switch; Adjustable time delay from ½ s to 15 s plus 25%.
- .10 Plug-in Construction Switches: CSA Type 4, two or four circuit, lever push or wobble stick type.
- .11 Illuminated with LED bulb of colour selected from manufacturer standard colours as reviewed with Consultant and suiting intended applications, or non-illuminated as noted.
- .12 Contact Ratings: As noted, suiting intended applications.
- .13 Aluminum faceplate with identification lettering nomenclature suiting intended applications.

2.08 OIL TIGHT SELECTOR SWITCHES

- .1 Heavy-duty and oil tight operators.
- .2 Satin chrome metal body and nut together with holder.
- .3 Multiple synthetic rubber seals prevent oil, water, coolants and dirt from entering unit.
- .4 Maintained or momentary suiting intended applications.
- .5 2 or 3-position suiting intended applications.
- .6 Operators short handle or long handle as noted.
- .7 Illuminated with LED bulb of colour selected from manufacturer standard colours as reviewed with Consultant and suiting intended applications, or non-illuminated as noted.
- .8 Contact arrangement and ratings as noted and suiting intended applications.
- .9 Aluminum faceplate with identification lettering nomenclature suiting intended applications.

2.09 KEY OPERATED OIL TIGHT SWITCHES

- .1 Heavy-duty and oil tight operators.
- .2 Satin chrome metal body and nut together with holder.

- .3 Multiple synthetic rubber seals prevent oil, water, coolants and dirt from entering unit.
- .4 Maintained or momentary suiting intended applications.
- .5 2 or 3-position suiting intended applications.
- .6 Key switch lock with keys: Keys removed in positions suiting intended applications.
- .7 Illuminated with LED bulb of colour selected from manufacturer standard colours as reviewed with Consultant and suiting intended applications, or non-illuminated as noted.
- .8 Contact arrangement and ratings as noted and suiting intended applications.
- .9 Aluminum faceplate with identification lettering nomenclature suiting intended applications.

2.10 EMERGENCY OFF PUSHBUTTONS (EPO)

- .1 Heavy-duty, oil tight operators.
- .2 Satin chrome metal body and nut together with holder.
- .3 Multiple synthetic rubber seals prevent oil, water, coolants and dirt from entering unit.
- .4 Oversized minimum 60 mm diameter, red plastic mushroom pushbuttons, as noted.
- .5 1-NO and 1-NC auxiliary contacts.
- .6 Illuminated with LED bulb of colour selected from manufacturer standard colours as reviewed with Consultant and suiting intended applications, or non-illuminated as noted.
- .7 Shroud and provision for padlocking in depressed position.
- .8 Aluminum faceplate labelled "EMERGENCY STOP" or other nomenclature as required suiting intended application.

2.11 OIL TYPE INDICATING LIGHTS

- .1 Heavy-duty, oil tight operators.
- .2 Satin chrome metal body and nut together with holder.
- .3 Multiple synthetic rubber seals prevent oil, water, coolants and dirt from entering unit.
- .4 LED bulbs of colour selected from manufacturer standard colours as reviewed with Consultant and suiting intended applications, or non-illuminated as noted.
- .5 Full voltage or 24 V with transformer, as reviewed with Consultant and suiting intended applications.
- .6 Push-to-test, lens colour and supply voltage as noted, suiting intended applications.
- .7 Aluminum faceplate with identification lettering nomenclature suiting intended applications.

2.12 OPERATOR CONTROL STATIONS

- .1 Flush Panel-Mounted:
 - .1 Pushbutton, switch operators and indicating lights, suiting intended applications.
 - .2 Direct mounting through panel openings or with stainless steel mounting faceplate, suiting intended applications.
 - .3 Engraved nameplates with identification of operations.

- .2 For surface mounted stations, provide suitable surface box with provisions for mounting of devices.

2.13 ENCLOSURES AND MOUNTING

- .1 Enamel painted steel or stainless steel faceplate as noted, for flush-mounting onto recessed wall boxes or in millwork, suitable for mounting of devices.
- .2 Climate-controlled Areas Surface Mounting: Minimum NEMA 1 unless otherwise noted.
- .3 Non-climate-controlled Areas Surface Mounting: Minimum NEMA 3R unless otherwise noted.
- .4 Flip-open polycarbonate tamper-proof cover and audible alarm device activated when cover is open, and custom labelling, as noted.
- .5 Sized accommodating mounted operators and devices.
- .6 Engraved nameplates with identification of operations.

2.14 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Operator Control Devices:
 - .1 Rockwell Automation (Allen Bradley).
 - .2 Eaton.
 - .3 Schneider.
 - .4 Siemens.
 - .5 ABB.

3. Execution

3.01 INSTALLATION

- .1 Refer to drawings or schedules for specific various options for control devices, generally described in this Section.
- .2 Install pushbutton stations, indicator lights, control and relay panels, thermostats and other control devices and interconnect with equipment suiting various applications.
- .3 Where surface mounted in climate-controlled areas: Mount devices in NEMA 1 box unless otherwise noted.
- .4 Where surface mounted in non-climate-controlled areas: Mount devices in NEMA 3R box unless otherwise noted.
- .5 Provide control transformers where required for connecting devices, suiting intended applications.
- .6 Program programmable devices and set selectable settings to perform sequence of operations reviewed with Consultant.
- .7 Install products in accordance with manufacturer instructions.
- .8 Where flush-mounted, provide faceplate suitable for mounting onto recessed boxes.
- .9 Ground and bond devices.
- .10 Coordinate work and interconnections to equipment, with respective equipment vendors.

- .11 Review finishes, indicating light colours, labelling and identification nomenclature with Consultant.

3.02 IDENTIFICATION AND SIGNAGE

- .1 Provide product identification.
- .2 Nameplate for Enclosures: Size 2 unless otherwise noted, and engraved as noted.
- .3 Provide engraved lamicoid nameplate to identify system being operated, identifying circuit number and panel feeding device.
- .4 Provide signage identifying special instructions.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing and Verification:
 - .1 Inspect, start-up, test and verify products.
 - .2 Depending upon magnitude and complexity as reviewed with Consultant, divide control system into convenient sections, energize one section at a time and check out operation of section.
 - .3 Upon completion of sectional test, undertake group testing.
 - .4 Test and verify devices and complete systems, for operational sequencing.
 - .5 Check connections and operations.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 14-[18(2022)], Industrial Control Equipment.
- .2 Underwriters Laboratory (UL):
 - .1 ANSI/UL 508-[2021], Standard for Industrial Control Equipment.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer printed product literature, specifications, installation instructions, and datasheets. and
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Indicate for each type of starter:
 - .1 Mounting method and dimensions.
 - .2 Starter size, rating and type.
 - .3 Layout and components.
 - .4 Enclosure types.
 - .5 Wiring diagram.
 - .6 Interconnection diagrams.
- .3 Submit testing and verification reports.

2. Products

2.01 GENERAL

- .1 Refer to detailed requirements noted in Motor Starter Schedules.
- .2 Starter standards in accordance with:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 CSA C22.2 No. 14.
 - .3 ANSI/UL 508.
- .3 Starter Voltage: Matches connected motor.
- .4 NEMA Size and Enclosure Type: As noted.
- .5 Accessories and enclosures: As noted, and fully assembled at motor starter manufacturer factory. Refer to Section 26 29 03 - Control Devices for additional requirements for accessories such as pushbuttons, switches, indicating lights and other control devices.
- .6 Starter and Motor Combinations (unless otherwise noted):

- .1 3 Phase Motors Less Than 50 Horsepower (HP): Combination "quick make" and "quick break" fused disconnects and full voltage, non-reversing magnetic types for across the line service.
- .2 3 Phase Motors From 50 HP Up to 150 HP: Reduced voltage, non-reversing, autotransformer types.
- .3 3-Phase Motors 150 HP or Larger: Reduced voltage, non-reversing, closed transition "wye delta" types.
- .4 2-Speed Single and Double Winding Motors: Equipped with 45 second time delay, permitting equipment to coast down to low speed before it is operated at low speed.
- .5 Reversible Motors for Cooling Towers Motors: Equipped with 45 second time delay, allowing fans to coast down to stop before being operated in reverse rotation.
- .6 2 Speed Fan Motors: 2 speed type suitable for use with 2 speed double winding motor and with 45 second time delay, allowing fan to coast down to low speed before it is operated at low speed.

2.02 MANUAL MOTOR STARTERS

- .1 Manual motor starters as follows:
 - .1 Three Phase or Single-Phase: As noted.
 - .2 Size, Type, Rating, and Enclosure Type: As noted.
 - .3 Switching Mechanism: Quick-make and quick-break.
 - .4 Overload Heaters:
 - .1 For each phase.
 - .2 Manual reset.
 - .3 Trip-indicating handle.
- .2 Accessories:
 - .1 Pushbuttons, key and toggle switches: Standard, oiltight, or heavy-duty types, and labeled accordingly.
 - .2 Indicating Light: Neon, oiltight, heavy-duty types, and of various colours, as noted.
 - .3 Operators with locking tab permitting padlocking in "ON" or "OFF" position.
 - .4 Surface or flush mounting NEMA enclosure, suiting intended applications.
 - .5 Where automatic and manual operation is required: "Hand-Off-Automatic" selector switches.

2.03 SINGLE PHASE BUILDING AUTOMATION STARTER

- .1 Building automation system connected starter of size, type, rating and enclosure type as noted, suiting intended applications and as follows:
 - .1 NEMA Type 1 enclosure.
 - .2 120 to 230 VAC, 1-Phase, 50/60 Hz input, across-the-line, full-voltage non-reversing (1 HP).
 - .3 Concealed Hand/Auto switch or lockable motor-rated On/Off switch.
 - .4 LED indicator lights for power, run and fault.
 - .5 Run Status Verification.

- .6 Voltage and dry inputs for Auto Run Command. Accepts 12 to 250 VAC/DC. Applying voltage sends run command to starter when in Auto mode. Normally Open dry contact when closed, starter commanded to run when in Auto mode.
- .7 System Override Mode (Firefighter, Occupancy or Manual).
- .8 One 16 A Class 10 Electronic Overload.
- .9 Fault Reset: Manual or Automatic.
- .10 Power Fail Mode: Return to last mode starter placed in (Hand-Off-Auto) with no delay (default).

2.04 FULL VOLTAGE NON-REVERSING MAGNETIC STARTERS

- .1 Magnetic and combination full voltage non-reversing magnetic starters of size, type, rating and enclosure type as noted, suiting intended application and as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Permanent number marking identical to diagram, identifying each wire and terminal for external connections.
- .2 Combination type starters include:
 - .1 Motor circuit interrupter: Circuit breaker or fused disconnect switch devices with operating lever on outside of enclosure to control device.
 - .2 Locking in "OFF" position with up to 3 padlocks.
 - .3 Independent locking of enclosure door.
 - .4 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
 - .1 Pushbuttons, key and toggle switches: Standard, oiltight, or heavy-duty types, and labeled accordingly.
 - .2 Indicating Light: Neon, oiltight, heavy-duty types, and of various colours, as noted.
 - .3 Operators with locking tab permitting padlocking in "ON" or "OFF" position.
 - .4 Surface or flush mounting NEMA enclosure, suiting intended applications.
 - .5 Where automatic and manual operation is required: "Hand-Off-Auto" selector switches.
 - .6 Auxiliary control devices and 1-NO and 1-NC spare auxiliary contacts.

2.05 FULL VOLTAGE REVERSING MAGNETIC STARTERS

- .1 Full voltage reversing magnetic starters of size, type, rating and enclosure type as noted, suiting intended applications and as follows:
 - .1 Two-3 pole magnetic contactors mounted on common base.
 - .2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.
 - .3 Three overload relays with heater elements, automatic or manual reset.
- .2 Accessories:

- .1 Pushbuttons, key and toggle switches: Standard, oiltight, or heavy-duty types, and labeled accordingly.
- .2 Indicating Light: Neon, oiltight, heavy-duty types, and of various colours, as noted.
- .3 Operators with locking tab permitting padlocking in "ON" or "OFF" position.
- .4 Surface or flush mounting NEMA enclosure, suiting intended applications.
- .5 Where automatic and manual operation is required: "Hand-Off-Auto" selector switches.
- .6 Auxiliary contacts and control devices.

2.06 MULTI-SPEED STARTERS

- .1 2 speed starters of size, type, rating and enclosure type as noted, suiting intended applications. Starter suitable for variable torque, constant torque, or constant kW type motor, and with components as follows:
 - .1 One-3 pole contactor for each winding for separate winding motors.
 - .2 One-3 pole and one-5 pole contactor for each reconnectable winding for consequent pole type motors.
 - .3 Three overload relays with 3 heater elements and manual reset for each speed.
- .2 Accessories:
 - .1 Pushbuttons, key and toggle switches: Standard, oiltight, or heavy-duty types, and labeled accordingly.
 - .2 Indicating Light: Neon, oiltight, heavy-duty types, and of various colours, as noted.
 - .3 Operators with locking tab permitting padlocking in "ON" or "OFF" position.
 - .4 Surface or flush mounting NEMA enclosure, suiting intended applications.
 - .5 Where automatic and manual operation is required: "Hand-Off-Auto" selector switches.
 - .6 Auxiliary contacts and control devices.
 - .7 Automatic sequence, low speed compelling relay, decelerating/accelerating relays for each speed, suiting intended applications, and as noted.

2.07 MAGNETIC STARTER, REDUCED VOLTAGE, AUTO-TRANSFORMER

- .1 Auto-transformer starter closed circuit transition type, of size, type, rating and enclosure as noted, suiting intended applications and as follows:
 - .1 Three-3 pole contactors.
 - .2 Auto-transformer with 50%, 65% and 80% taps, or 65% and 85% taps.
 - .3 One adjustable pneumatic timing relay.
 - .4 One-3 pole manual reset overload device.
 - .5 Thermal overload protection of auto-transformers.
- .2 Combination type starters include:
 - .1 Circuit breaker devices with operating lever on outside of enclosure to control device.
 - .2 Locking in "OFF" position with up to 3 padlocks.
 - .3 Independent locking of enclosure door.

- .4 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
 - .1 Pushbuttons, key and toggle switches: Standard, oiltight, or heavy-duty types, and labeled accordingly.
 - .2 Indicating Light: Neon, oiltight, heavy-duty types, and of various colours, as noted.
 - .3 Operators with locking tab permitting padlocking in "ON" or "OFF" position.
 - .4 Surface or flush mounting NEMA enclosure, suiting intended applications.
 - .5 Where automatic and manual operation is required: "Hand-Off-Auto" selector switches.
 - .6 Auxiliary contacts and control devices.

2.08 MAGNETIC STARTER REDUCED VOLTAGE STAR-DELTA

- .1 Reduced voltage star-delta open transition starter, of size, type, rating and enclosure as noted, suiting intended applications and as follows:
 - .1 Two-3 pole delta contactors with auxiliary relays and interlocks.
 - .2 One-3 pole star contactor with auxiliary relays and interlocks.
 - .3 Mechanical interlock to interlock one delta contactor and star contactor.
 - .4 One timing relay.
 - .5 Three pole automatic and manual reset overload relays.
- .2 Reduced voltage star-delta closed transition starter, of size, type, rating and enclosure as noted, suiting intended applications and as follows:
 - .1 Two-3 pole delta contactors with auxiliary relays and interlocks.
 - .2 One-3 pole star contactor with auxiliary relay and interlocks.
 - .3 One-3 pole transition contactor.
 - .4 One set of transition resistors.
 - .5 Mechanical interlock, to interlock one delta contactor and star contactor.
 - .6 One timing relay.
 - .7 Three pole automatic and manual reset overload relays.
- .3 Combination type starters include:
 - .1 Circuit breaker devices with operating lever on outside of enclosure to control device.
 - .2 Locking in "OFF" position with up to 3 padlocks.
 - .3 Independent locking of enclosure door.
 - .4 Provision for preventing switching to "ON" position while enclosure door open.
- .4 Accessories:
 - .1 Pushbuttons, key and toggle switches: Standard, oiltight, or heavy-duty types, and labeled accordingly.
 - .2 Indicating Light: Neon, oiltight, heavy-duty types, and of various colours, as noted.
 - .3 Operators with locking tab permitting padlocking in "ON" or "OFF" position.
 - .4 Surface or flush mounting NEMA enclosure, suiting intended applications.

- .5 Where automatic and manual operation is required: "Hand-Off-Auto" selector switches.
- .6 Auxiliary contacts and control devices.

2.09 MAGNETIC STARTER REDUCED VOLTAGE PART WINDING

- .1 Two-step reduced voltage, part winding starter of size, type, rating and enclosure type as noted, suiting intended applications and as follows:
 - .1 Two-3 pole contactors.
 - .2 Adjustable pneumatic timer.
 - .3 Six automatic and manual reset overload relays.
- .2 Three step reduced voltage part winding starter of size, type, rating and enclosure type as noted, suiting intended applications and as follows:
 - .1 Three-3 pole contactors.
 - .2 One set starting resistors.
 - .3 Six automatic and manual reset overload relays, suiting intended applications, and as noted.
- .3 Combination type starters include:
 - .1 Circuit breaker devices with operating lever on outside of enclosure to control device.
 - .2 Locking in "OFF" position with up to 3 padlocks.
 - .3 Independent locking of enclosure door.
 - .4 Provision for preventing switching to "ON" position while enclosure door open.
- .4 Accessories:
 - .1 Pushbuttons, key and toggle switches: Standard, oiltight, or heavy-duty types, and labeled accordingly.
 - .2 Indicating Light: Neon, oiltight, heavy-duty types, and of various colours, as noted.
 - .3 Operators with locking tab permitting padlocking in "ON" or "OFF" position.
 - .4 Surface or flush mounting NEMA enclosure, suiting intended applications.
 - .5 Where automatic and manual operation is required: "Hand-Off-Auto" selector switches.
 - .6 Auxiliary contacts and control devices.

2.10 THREE PHASE MANUAL REVERSING STARTERS

- .1 Three phase manual reversing starter of size, type, rating and enclosure type as noted, suiting intended applications and as follows:
 - .1 Two-3 pole manual motor starters, quick make and break.
 - .2 Six overload relays and manual reset.
 - .3 Mechanical interlock preventing both switches from closing at same time.
- .2 Accessories:
 - .1 Pushbuttons, key and toggle switches: Standard, oiltight, or heavy-duty types, and labeled accordingly.

- .2 Indicating Light: Neon, oiltight, heavy-duty types, and of various colours, as noted.
- .3 Operators with locking tab permitting padlocking in "ON" or "OFF" position.
- .4 Surface or flush mounting NEMA enclosure, suiting intended applications.
- .5 Auxiliary contacts and control devices.

2.11 THREE PHASE MANUAL TWO SPEED SEPARATE WINDING STARTERS

- .1 Three phase manual two speed separate winding starters of size, type, rating and enclosure type as noted, suiting intended applications and as follows:
 - .1 Two-3 pole manual motor starters, quick make and break.
 - .2 Six overload relays and manual reset.
 - .3 Mechanical interlock preventing both switches from closing at same time.
- .2 Accessories:
 - .1 Pushbuttons, key and toggle switches: Standard, oiltight, or heavy-duty types, and labeled accordingly.
 - .2 Indicating Light: Neon, oiltight, heavy-duty types, and of various colours, as noted.
 - .3 Operators with locking tab permitting padlocking in "ON" or "OFF" position.
 - .4 Surface or flush mounting NEMA enclosure, suiting intended applications.
 - .5 Auxiliary contacts and control devices.

2.12 DC FULL VOLTAGE NON-REVERSING STARTERS

- .1 DC full voltage non-reversing starters of size, type, rating and enclosure type as noted, suiting intended applications and as follows:
 - .1 Contactor: Two and single pole, solenoid operated type, suiting intended applications, and as noted.
 - .2 Indirectly heated manual reset thermal overload relay.
- .2 Accessories:
 - .1 Pushbuttons, key and toggle switches: Standard, oiltight, or heavy-duty types, and labeled accordingly.
 - .2 Indicating Light: Neon, oiltight, heavy-duty types, and of various colours, as noted.
 - .3 Operators with locking tab permitting padlocking in "ON" or "OFF" position.
 - .4 Surface or flush mounting NEMA enclosure, suiting intended applications.
 - .5 Where automatic and manual operation is required: "Hand-Off-Automatic" selector switches.
 - .6 Auxiliary contacts and control devices.

2.13 DC FULL VOLTAGE REVERSING STARTERS

- .1 DC full voltage reversing starter of size, type, rating and enclosure type as noted, suiting intended applications and as follows:
 - .1 Two Contactors: Single and two poles, solenoid operated type, mechanically and electrically interlocked.
 - .2 Indirectly-heated, manual reset thermal overload relay.

- .2 Accessories:
 - .1 Pushbuttons, key and toggle switches: Standard, oiltight, or heavy-duty types, and labeled accordingly.
 - .2 Indicating Light: Neon, oiltight, heavy-duty types, and of various colours, as noted.
 - .3 Operators with locking tab permitting padlocking in "ON" or "OFF" position.
 - .4 Surface or flush mounting NEMA enclosure, suiting intended applications.
 - .5 Where automatic and manual operation is required: "Hand-Off-Auto" selector switches.
 - .6 Auxiliary contacts and control devices.

2.14 CONTROL TRANSFORMERS

- .1 Single phase, dry type, control transformer with primary voltages and secondary voltages, complete with secondary fuse.
- .2 Size control transformer for control circuit load plus 20% spare capacity.
- .3 Suiting intended applications, and as noted.

2.15 RELAYS

- .1 For applications where motor protection is required, provide solid state overload relays with following features:
 - .1 Self-powered, ambient compensated.
 - .2 Phase Loss Protection.
 - .3 Visible trip indication.
 - .4 Selectable trip class settings (10, 15, 20 or 30).
 - .5 1 NO and 1 NC isolated auxiliary contacts, unless otherwise noted.

2.16 ENCLOSURES

- .1 Enclosures (when not mounted in motor control centres) of types in accordance with following NEMA ratings, unless otherwise noted:
 - .1 Climate-Controlled Areas: Minimum NEMA 2 with drip shield.
 - .2 Non-Climate-Controlled Areas: Minimum NEMA 3R, constructed of stainless steel.
 - .3 Explosion Rated Areas: NEMA 7 with exact requirements in accordance with requirements of building code suiting area and application.
 - .4 Finished Areas: As above but recess type with brushed stainless steel faceplate.
- .2 Finishes:
 - .1 Manufacturer standard ANSI gray enamel finish, as reviewed with Consultant.

2.17 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Motor Starters:
 - .1 Rockwell Automation (Allen-Bradley).
 - .2 Eaton.
 - .3 Siemens.
 - .4 Schneider.

3. Execution

3.01 INSTALLATION OF MOTOR STARTERS

- .1 Coordinate with other Divisions, exact responsibilities for supply, installation, testing and verification of motor starters.
- .2 Provide loose motor starters for equipment as coordinated with equipment vendors, except for starters integral with packaged equipment and starters factory installed in equipment power and control panels.
- .3 Refer to Motor Starter Schedules and Motor Control Centre Schedules.
- .4 Where 3-phase starters are mounted on motor starter panel, mount and connect starters, with panels and splitter trough.
- .5 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from motor starter panel, provide disconnect switch on motor starter panel.
- .6 Mount and connect 1-phase motor starters adjacent to equipment they serve.
- .7 Install starters and control devices in accordance with manufacturer instructions.
- .8 Install wiring, starters and controls.
- .9 Provide motor starter interlocking in accordance with requirements of equipment vendors, work of other Divisions and as outlined on starter schedules. Equip each starter being interlocked, with contacts and control connection accessories.
- .10 Provide additional disconnect switches complete with identification, in accordance with Section 26 28 23 - Disconnect Switches – Fused and Non-Fused.
- .11 Make connections to thermistors and provision of additional relays for connections to starters. Review other Division Sections and drawings defining these requirements and include work, wiring, conduit and components.
- .12 Provide interconnection circuits to integrate starters to BAS. Extend wiring in conduit to interconnection terminal cabinet. Provide wiring in conduit from cabinet to respective BAS panel serving area. Make connections. Coordinate requirements with respective equipment vendors.
- .13 Ground and bond devices.

3.02 IDENTIFICATION

- .1 Provide identification nameplate on each motor starter or disconnect located on motor starter panel, and on each individually mounted starter.
- .2 Review motor nameplate and adjust overload device suiting nameplate rating.
- .3 Nameplates (unless otherwise noted): White lamicoid nameplate, black letters, size 1 and suitably sized as noted, suiting intended applications.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing and Verification:
 - .1 When installation is complete, check and test operation of each starter and verify that equipment is in proper operating condition.
 - .2 Verify that starter voltage matches connected motor. Start associated motors under imposed loads.

- .3 Verify that correct fuses are installed.
 - .4 Review motor nameplate and adjust overload device, suiting nameplate rating.
 - .5 Perform starting and stopping sequences of contactors and relays to verify correct operation.
 - .6 Inspect and test that sequence controls, interlocking with other separate related starters, equipment and control devices, operate correctly, providing functionality as specified.
- .2 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA B149.1-[20], Natural Gas and Propane Installation Code.
 - .2 CSA C22.2 No. 100-[14(R2019)], Motors and Generators.
 - .3 CAN/CSA-C22.2 No. 107.2-[01(R2021)], Battery Chargers.
 - .4 CSA C282-[19], Emergency Electrical Power Supply for Buildings.
 - .5 CSA G40.20-[13]/G40.21-[13(R2023)], General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .2 Government of Ontario:
 - .1 O. Reg. 524/98-[2019], Environmental Compliance Approvals - Exemptions from Section 9 of the Act, under Environmental Protection Act, R.S.O. 1990, c. E.19.
- .3 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE 485-[2020], IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications.
 - .2 IEEE 1187-[2013], IEEE Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications.
 - .3 IEEE 1188a-[2014], IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications - Amendment 1: Updated VRLA Maintenance Considerations.
- .4 International Organization for Standardization (ISO):
 - .1 ISO 3046-1-[2002], Reciprocating Internal Combustion Engines - Performance - Part 1: Declarations of Power, Fuel and Lubricating Oil Consumptions, and Test Methods - Additional Requirements for Engines for General Use.
- .5 National Electrical Manufacturers Association (NEMA):
 - .1 ANSI/NEMA MG 1-[2021], Motors and Generators.
- .6 National Fire Protection Association (NFPA):
 - .1 NFPA 110-[2022], Standard for Emergency and Standby Power Systems.
- .7 Underwriters Laboratories (UL):
 - .1 ANSI/UL 94-[2021], Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
 - .2 CAN/ULC S1001-[2023], Standard for Integrated System Testing of Fire Protection and Life Safety.
- .8 Comply with versions of codes and standards adopted and enforced by AHJ. Confirm with AHJ and review issues with Consultant.

1.02 SUBMITTALS

- .1 Where generator sets (gensets) are installed in enclosures, coordinate submittal requirements with requirements and products of Section 26 32 40 - Generating Units Enclosures.

- .2 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Submit complete design, erection and layout drawings for system, indicating wiring requirements, interfacing or interconnection provisions to completely integrate controls with remote apparatus.
 - .3 Include:
 - .1 Engine: Make and model, with performance curves.
 - .2 Alternator: Make and model.
 - .3 Genset continuous full load output of set at 0.8 PF lagging.
 - .4 Voltage Regulator: Make, model and type.
 - .5 Automatic Transfer Switch: Make, model and type.
 - .6 Batteries:
 - .1 Make, type and capacity.
 - .2 Maximum charging current recommended for fully discharged condition.
 - .7 Battery Charger: Make, type and model.
 - .8 Alternator Control Panel: Make and type of meters and controls.
 - .9 Breakers: Types, ratings and tripping functions.
 - .10 Governor: Type and model.
 - .11 Ventilation system components.
 - .12 Cooling air requirements in m³/s.
 - .13 General outline drawing of complete assembly showing:
 - .1 Engine, radiator, generator mounting, fuel tank and enclosure as applicable.
 - .2 Exhaust, recirculating and intake air louvre arrangement, exhaust gas silencer and pipe arrangement.
 - .3 Locations of lubricating oil filters, fuel supply and return line connections, lubricating oil drain valve, radiator and coolant drain valves and air cleaner.
 - .4 Engine instrument panel, starting motor, power and control junction boxes.
 - .5 Engine and generator mounting feet and vibration isolators.
 - .14 Drawings identifying:
 - .1 Horizontal and vertical dimensions.
 - .2 Outline and layout of panels.
 - .3 Locations of components.
 - .4 Weight of engine, generator, baseplate, radiator, exhaust silencer and enclosure (as applicable).
 - .5 Total weight.
 - .15 Description of genset operation including:

- .1 System sequence of operation with automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency.
 - .2 Manual starting.
 - .3 Automatic shut down and alarm on:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temp.
 - .4 Low lube oil pressure.
 - .5 Short circuit.
 - .6 Alternator over voltage.
 - .7 Lube oil high temperature.
 - .8 Over temperature on alternator.
 - .4 Manual remote emergency stop.
 - .16 Schematic and field wiring diagrams of engine, generator, control panel, and automatic transfer switch with interconnecting wiring diagrams.
 - .17 Single line diagram showing breakers, switches, metering and protective relays.
 - .18 Diagram of lubricating oil system.
 - .19 Flow diagrams for:
 - .1 Natural gas fuel.
 - .2 Cooling air.
 - .20 Dimensioned drawing showing battery rack.
 - .21 Bill of materials, including manufacturer name, catalogue numbers and capacity.
- .4 Submit electronic copy of custom control system software with sequence of operations, in format acceptable to Owner and reviewed with Consultant.
 - .5 Submit certification of proposed gensets, verifying prototype testing as fully integrated assembly at vendors factory, and verifying CSA certification.
 - .6 Submit genset manufacturer certificate verifying that supplying Canadian distributor is manufacturer authorized dealer in place of Work.
 - .7 Submit compliance certificates, and testing and verification reports.

1.03 QUALITY ASSURANCE

- .1 Gensets: CSA certified, and type tested in vendor plant. Include prototype testing as follows:
 - .1 Factory test genset using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - .2 NFPA 110, Level 1: Equipment engine, skid, cooling system, and alternator subjected to actual prototype tests, validating capability of design under abnormal conditions noted in NFPA 110. Calculations and testing on similar equipment which are allowed under NFPA 110 are not sufficient to meet this requirement.

- .2 Assemble genset with control system wired and pre-tested prior to shipment to site. Tests subject to witnessing by Consultant at Consultant discretion. Prior to gensets leaving plant, rectify defects and retest.

1.04 CLOSEOUT SUBMITTALS

- .1 Include in Operation and Maintenance Manual instructions for specific unit supplied and not general description of units manufactured by supplier.
- .2 Include operation and maintenance instructions for effective operation, maintenance and repair of following:
 - .1 Engine and alternator.
 - .2 Voltage regulator, starting motor, starting system, control system and control panel.
 - .3 Automatic transfer switch and manual bypass switch.
 - .4 Battery charger and batteries.
 - .5 Fuel system.
 - .6 Cooling system.
 - .7 Ventilation system.
 - .8 Exhaust system.
 - .9 Accessories.
- .3 Include Technical Data as follows:
 - .1 Illustrated parts lists with parts catalogue numbers.
 - .2 Schematic diagram of electrical controls.
 - .3 Flow diagrams for:
 - .1 Fuel system.
 - .2 Lubricating oil.
 - .3 Cooling system.
 - .4 Control system software programming.
 - .5 Certified copy of factory test results.
 - .6 Maintenance and overhaul instructions and schedules.
 - .7 Precise details for adjustment and setting of time delay relays or sensing controls which require on site adjustment.

1.05 REGULATORY REQUIREMENTS

- .1 In accordance with Technical Standards and Safety Authority (TSSA).
- .2 Noise and Emissions:
 - .1 In accordance with O. Reg. 524/98 necessary technical data (environmental, noise and emissions and performance), such that genset and installation on this project is exempt from requirements in obtaining required approvals or certifications from or registration with Ministry of Environment – Climate Change – Environment Activity and Sector Registry (MOECC EASR) for generator registration.
 - .2 In accordance with EPA exhaust Tier limits based upon engine maximum horsepower rating and other Ministry of Environment regulations, and requirements specified.

1.06 DELIVERY, STORAGE AND HANDLING

- .1 Genset vendor to deliver genset units and accessories to project curbside and coordinate unloading and ready for inspection by Consultant and Commissioning Agent.
- .2 Coordinate requirements with general trades and hoist and transport units into installation location onsite.

1.07 WARRANTY

- .1 Warrant (full 100% parts and labour with no deductible amounts) gensets and control system equipment in writing, to be in accordance with Specification and free from defects for 1 year from date of turn over to Owner. Warranty period starts after acceptance tests and subsequent written recommended for acceptance by Consultant and after full connection to building load.
- .2 Include for manufacturer/vendor authorized technician 24-hours around clock service for onsite genset and equipment.
- .3 Include with warranty, following:
 - .1 Manufacturer routine maintenance service including parts and labour.
 - .2 Complete oil and filter changes at manufacturer recommended intervals to maintain warranty validity.
 - .3 Manufacturer recommended maintenance and servicing to maintain validity of warranty.
- .4 Service and maintenance requirements in accordance with CSA C282

2. Products

2.01 SYSTEM DESCRIPTION

- .1 Engine generator (gensets) units consists of:
 - .1 Natural gas-powered engines.
 - .2 Alternator.
 - .3 Unit control panels.
 - .4 Fuel system, starting system, cooling system, exhaust system.
 - .5 Automatic transfer equipment.
 - .6 Battery chargers and batteries.
 - .7 Where indicated, synchronization and paralleling controls and switchgear or switchboard.
 - .8 Steel mounting bases.
 - .9 Where specified that genset is provided in enclosure, include enclosure with ventilation system, fuel supply system and exhaust system as specified or as indicated, or scheduled.
 - .10 Other components as noted.
- .2 Gensets Capacities and Ratings:
 - .1 As indicated, or scheduled, which are at 0.8 power factor and include 10% overload.
 - .2 Ratings are nameplate ratings.

- .3 Capable of operating at 100% of nameplate rating at rated RPM in ambient temperature of 40°C without overheating, or suffering other detrimental effects, at rated generator RPM when genset is equipped with operating accessories.
- .4 Capable of starting, attaining settled voltage and frequency limits and accepting single full rated load step for nameplate rating with voltage and frequency settling to CSA C282 specified steady state bands, within 15 seconds for temperatures between 0°C to 40°C.
- .5 Use engine manufacturer standard, published continuous prime horsepower rating in assessing engine capacity and derating this rating for specified conditions and engine driven accessories in accordance with ISO 3046-1.
- .3 Description of Generating Set Operation:
 - .1 Automatic starting on abnormal or loss of normal voltage: Voltage sensing relays to sense three phases of normal power (hydro) supply.
 - .2 When voltage on any one phase drops below preset limits (adjustable) for adjustable period of time, closes engine start contacts and starts engine.
 - .3 When emergency supply reaches settled voltage and frequency preset limits (adjustable), transfer switch transfers load to emergency supply.
 - .4 Continues to supply load until normal power supply returns or genset shuts down manually or under failure conditions.
 - .5 On normal power restoration, confirmed by three phase sensing of voltage above adjustable preset, for period in excess of three minutes (adjustable), transfer switch transfers load to normal supply.
 - .6 Provides dead bus timer allowing motor starters to drop out and motors to stop prior to connecting to normal power supply.
 - .7 Adjustable time delay relay allows engine to run unloaded to cool down and subsequently shutdowns, ready for next cycle.
 - .8 Equips engine with key switch with following positions: Auto-off-crank-start, key removable in auto position only.
 - .9 Automatic shut down on:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temperature.
 - .4 Low lubricating oil pressure.
 - .5 Over and under frequency.
 - .6 Emergency breaker failure.
 - .7 Electrical fault lock-out on short circuit and generator over and under voltage.
- .4 Enclose moving parts such as flywheels, pulleys and belts, and hot parts such as manifolds and extensions up to and including exhaust pipes, with guards to protect persons from injury. Locate guards allowing for normal daily maintenance inspections without their removal. Guards are easily removable for servicing equipment. Provide guards in accordance with requirements of AHJ.
- .5 Genset manufacturer or vendor to review engine exhaust system design and verify in writing that back pressure does not impair operation and output of gensets. Submit confirmation certificate to Consultant.

- .6 Genset driven radiator fan is capable of overcoming minimum of 13 mm water column pressure drop in ambient temperature of 40°C. Review complete air intake and exhaust system design with regards to air restrictions and provide oversized fans with blades of extra strength, overcoming additional pressure drop through fresh air intake, discharge silencers, and other related factors, as required. Identify on shop drawings, compliance with this requirement.
- .7 Provide following:
 - .1 System sequence of operation with software.
 - .2 Review of electrical distribution system, verifying that genset grounding provisions are compatible and are in compliance with electrical code requirements.
 - .3 Where gensets are provided in enclosures for locating exterior of building at ground level, examine proposed installation location and coordinate other trades work in providing concrete bases, protection bollards and fuel lines and connections.
 - .4 Coordination with other trades and system vendors for integration of work.
 - .5 Demonstration, set-up, inspection, testing and verification of genset operation and associated systems operations.
 - .6 Instructions on operating and maintenance.

2.02 ENGINES

- .1 Type: Natural gas fuel powered, turbo supercharged, nominal speed 1800 rpm, minimum 4 cylinders, vertical in-line or vee, and current manufacture of type and size that has been service for electric power generation for not less than two years.
- .2 Engines equipped with:
 - .1 Interchangeable cylinder heads, exhaust valves constructed of special alloy steel, and non-magnetic and corrosion-resistant cobalt alloy faced exhaust valve inserts.
 - .2 Lubricating systems of full pressure oiling type through internally mounted, high capacity, positive displacement type gear pumps with adjustable pressure regulators, lubricating oil cooler and full flow oil filters.
 - .3 Full pressure lubrication to main bearings, connecting rod bearings and camshaft bearings.
 - .4 Drain canisters on air boxes.
 - .5 Electronic governor with speed control and magnetic pickup assembly capable of maintaining speed and voltage regulation within limits previously specified. Provide electronic governor of type recommended by genset manufacturer to provide performance suiting intended application.
 - .6 12 or 24 VDC suiting intended applications, electric starting motors with starting pinion arranged to disengage automatically when respective engine starts.
 - .7 Individual safety devices to shut down engine and to sound alarm in event of conditions specified later in this Section.
 - .8 Contacts pre-alarming for conditions specified later in this Section.
 - .9 Sensors connecting to electronic controls to monitor and display various engine performance characteristics.
 - .10 Filters on Air Intake to Engine: Dry vortex type with replaceable elements.

- .11 Soldered galvanized steel drip pan: Placed beneath engine to catch leakage from set.
- .3 Engine mounted accessories are readily removable without dismantling engine alternator, or other accessories.
- .4 Lubrication System:
 - .1 Pressure lubricated by engine driven pump.
 - .2 Lube Oil Filter: Replaceable, full flow type, removable without disconnecting piping.
 - .3 Lube oil cooler.
 - .4 Wire braided engine oil extension hoses on oil drain extending out for easier access.
 - .5 Oil level dip-stick or level gauge.
 - .6 Brass type oil drain valves.
 - .7 Following provisions allow for easier access:
 - .1 Oil fill pipe extending out beyond protection screens.
 - .2 Fan hub grease fitting extending out beyond hub housing.
 - .3 Engine oil drain piping extended out to engine base.

2.03 ALTERNATORS

- .1 Alternators:
 - .1 In accordance with ANSI/NEMA MG 1 and CSA C22.2 No. 100.
 - .2 2/3 pitch.
 - .3 Revolving field, brushless, single bearing.
 - .4 Drip proof.
 - .5 Amortisseur windings.
 - .6 Synchronous type.
 - .7 Exciter: Permanent magnet, rotating brushless.
 - .8 Dynamically balanced rotor permanently aligned to engine by SAE flexible disc coupling.
 - .9 NEMA class H insulation on windings.
 - .10 Temperature rise not to exceed 130 C° as measured by resistance in ambient temperature 40°C.
 - .11 Grounding provisions compatible with electrical distribution system.
- .2 Resistor temperature detectors (RTD) type thermistors embedded in stator winding and connected to alternator control circuitry, are with relays or contacts, sending trouble signal to control panel. Control panel monitors warning signal of high temperature of windings.
- .3 Voltage Regulators:
 - .1 Thyristor controlled rectifiers with 3 phases-controlled sensing circuit.
 - .2 Radio suppression module, frequency choke to prevent damage to voltage regulator in case of lower than nominal engine speed.
 - .3 Adjustable stability circuit.
 - .4 Manual voltage adjustment potentiometer.
 - .5 Balanced Telephone Influence Factor (TIF): Not to exceed 50.

- .4 Alternators sustain 300% rated current for period not less than 10 seconds, permitting selective tripping of down line protective devices when short circuit occurs.
- .5 Voltage regulation systems maintain regulation within limits previously specified and include regulator and manual voltage adjustment potentiometer.
- .6 Extension Boxes on Alternators:
 - .1 Sufficient size accommodating:
 - .1 Corflex RA90 type, fire-rated flexible corrugated aluminum sheathed armoured cables with copper conductors, cross-linked polyethylene insulation and LAG/LFS PVC jacket.
 - .2 Current sensor for ground fault protection as specified in control panel.
 - .2 Connections manufactured to isolate cable from set and prevent transmission of vibration.
 - .3 Non-ferrous ground bushings.

2.04 ENGINE FUEL SYSTEMS

- .1 Fuel system consists of:
 - .1 Fuel gas pressure regulator, strainers, air/gas control valve, gas pressure monitoring devices with auxiliary contacts, turbo charger, throttle body, gas valve train and rack.
 - .2 Flexible connectors with braided stainless-steel covering, diameter and length suiting engine requirements. For each genset provide two natural gas flexible connectors, minimum 900 mm long, as coordinated with piping work of Mechanical Division 23.
- .2 Fuel system plumbed to genset skid base for ease of site connections.
- .3 Type, rating, sizing and manufacturers of components are as recommended by genset vendor, suiting intended applications and in accordance with requirements of AHJ.

2.05 EXHAUST SYSTEMS (ENCLOSURE UNITS)

- .1 Provide exhaust system for enclosures. Refer to Section 26 32 40 - Generating Units Enclosures, for additional requirements.

2.06 JACKET COOLANT HEATERS

- .1 Engine jacket coolant heaters include silicone hoses, immersion type thermostats, pressure switches and ball type-isolating valves on engine water connections.
- .2 Size heaters for maintaining coolant in engine at genset manufacturer rated temperature requirements with unit operating at rated loads and conditions. (approximately 6 kW, for each engine at 208 V, 1-phase, but review with genset vendor and revise suiting intended applications).
- .3 When engines are running, jacket heaters automatically disconnect via oil pressure switches or engine run relay.
- .4 Heaters connect to each engine with high temperature coolant silicone hoses and clamps, approved by AHJ for specific use for such applications.

2.07 COOLING SYSTEMS

- .1 Cooling system for engines consists of unit mounted air water radiator system with protective screen and 50% water/50% ethylene glycol coolant solution.

- .2 System maintains manufacturer recommended engine temperature range at full engine output rating in ambient temperature of 40°C.
- .3 Radiator system includes:
 - .1 High performance static pusher fan and fan motors.
 - .2 Radiator core guard, duct adapter flange and mounting frame.
 - .3 Expansion tank.
 - .4 Thermostatic controls and disconnect switch.
 - .5 Open mesh fan guard and shroud.
 - .6 Thermostat: Maintains coolant temperature at genset manufacturer rated temperature with genset operating at rated load. Size radiator to maintain these coolant conditions.
 - .7 Gate Drain Brass Ball Valves: Draining coolant from each engine block and radiator. Wire braided hoses, piping and fittings are silicone construction and extend into drain containment pan.
- .4 Block Heater: Thermostatically controlled lube oil or liquid coolant heater connected to line side of automatic transfer switch allowing engine to start in recommended set temperature to suit intended application.
- .5 Switch and fuse in heater circuit: Mounted in engine-alternator control cubicle and fed from line side of automatic transfer switch.

2.08 STARTING SYSTEMS

- .1 Starting system for engines consists of:
 - .1 Cranking starter motors.
 - .2 Batteries.
 - .3 Battery heater.
 - .4 Battery stand with insulation board.
 - .5 Battery cable.
 - .6 Battery chargers.
 - .7 Cranking motor cut-out switch (crank for three attempts with intervening periods during a period of no less than 45 seconds and no more than 75 seconds).
 - .8 Manufacturer recommended maintenance parts and tools.
- .2 Batteries:
 - .1 ULC listed and labeled.
 - .2 In accordance with ANSI/UL 94 V-0 safety requirements, and requirements of IEEE 1188a, IEEE 1187, and IEEE 485.
 - .3 Fully sealed, long life, absorbed glass mat (AGM), valve regulated lead acid (VRLA).
 - .4 Puncture-resistant micro-porous glass mat separators.
 - .5 Grid Alloys: Pure lead, high tin, low calcium.
 - .6 Plates: Flat.
 - .7 Posts: Brass threaded insert type, epoxy sealed.
 - .8 Case and Cover: Flame-retardant polypropylene construction in accordance with ANSI/UL 94 V-0, heat sealed, and 100% leak tested.

- .9 Cell self-sealing pressure relief valve that opens and closes within rated pressure values specified by manufacturer throughout life of battery. Valves 100% factory tested.
 - .10 Relief valve with flame arrestor preventing spark from entering cell.
 - .11 Designed for 10 years design life for continuous float operation at 25°C.
 - .12 Sufficient capacity in ambient temperature of 0°C to crank each unit at engine manufacturer recommended cranking starting speed for period of 60 seconds and without using more than 25% of ampere hour capacity.
 - .13 Voltage measured at starting motor terminals at end of cranking period specified above, with cranking current flowing, not less than 1.75 volts for each cell.
 - .14 Sized based on engine and battery manufacturer published data.
 - .15 Type and performance ratings as recommended by genset supplier, meeting starting requirements of genset. Submit data with shop drawings to substantiate choice of batteries.
- .3 Battery Racks:
- .1 Steel for Battery Racks: In accordance with CSA G40.20/G40.21.
 - .2 Frames: Angle iron with welded joints ground smooth. Structurally designed and constructed to support weight of batteries properly and safely.
 - .3 Rails: Steel channels, bolted to frames.
 - .4 Plastic or rubber strips insulating rails from cells.
 - .5 Insulated from ground and floor.
 - .6 Free-standing, not bolted to floor, and as reviewed with Consultant.
 - .7 Primed and epoxy painted preventing corrosion.
 - .8 Corrosion-resistant bolts and hardware.
 - .9 Jumper cables.
 - .10 Mounting bracket for accessories.
 - .11 Plywood base.
 - .12 PVC tray.
 - .13 Ancillary devices to connect, mount and install.
- .4 Battery Chargers:
- .1 As recommended by genset supplier.
 - .2 In accordance with CAN/CSA-C22.2 No. 107.2.
 - .3 Solid state, fully automatic operation, totally enclosed enclosure.
 - .4 Operating voltage of 115 volts, 60 cycle AC.
 - .5 Automatically maintain battery in fully charged state while mains power available.
 - .6 Temperature compensation adjustable in accordance with battery manufacturer specification.
 - .7 AC switch and overload protection isolating voltage ratio transformer, silicon-controlled rectifier assembly and DC protection, each suitable for 2 rates of charging (trickle charge and high rate of charge for use after engine start).
 - .8 Regulation: $\pm 1\%$ output for $\pm 10\%$ input variation.
 - .9 Automatic boost for 6 hours every 30 days.
 - .10 DC ammeter and dc voltmeter gauges, each with 2% accuracy.
 - .11 LEDs mounted on front for indications: Power On, Failure AC Power, Low DC Voltage, High DC Voltage, No Rectifier Output.

- .12 Common LED test switch.
 - .13 Float voltage adjustment.
 - .14 Equalize circuit.
 - .15 Overload protection.
 - .16 DC output protection.
 - .17 Maximum charge rate, suiting intended application.
 - .18 Contacts for connection of common alarm signal to control system.
- .5 Battery chargers recharge battery discharged by two cranking cycles (30 seconds each) to 80% of capacity within 4 hours and to full capacity in maximum 12 hours.

2.09 CONTROL PANELS

- .1 General Features:
 - .1 Microprocessor-based controller with LCD displays featuring multiple metering displays and graphics, with full options and features as specified. Provide user selectable metering in both digital and analogue.
 - .2 Short circuit capacities to suit maximum short circuit output of alternator.
 - .3 Totally enclosed enclosure, unit mounted on I-beam support base and vibration isolated from genset.
 - .4 Metering and controls display mounted at eye level.
 - .5 Hinged front door with door detent mechanism to maintain hinged door at open position.
 - .6 Enclosure painted with enamel finish to match genset body finish.
- .2 Controls and Monitoring Components Features
 - .1 Digital metering:
 - .1 0.5% accuracy, indicating generator RMS voltage and current, frequency, output current, output KW, KW hours, and power factor.
 - .2 Generator output voltage in line to line and line to neutral voltages.
 - .3 Displays all three phase voltages (line to neutral or line to line) simultaneously.
 - .2 Under frequency/over voltage control module with adjustable relay to trip main breaker on settings of $\pm 12\%$ of normal.
 - .3 Engine mounted gauges for oil temperature, oil pressure and engine coolant temperature.
 - .4 Starting battery monitoring.
 - .5 Monitoring integrity of genset remote start signal circuits for broken, disconnected, or shorted wires. Loss of integrity to start gensets. Install control conductors between transfer equipment and gensets entirely independent of other wiring.
 - .6 Control system initiates genset starting and stopping sequence and annunciate fault conditions (local or remote indication). Electronic control module monitors and provides digital display of genset functions. Operator interface alpha numeric display provides for viewing of genset data and provides setup, controls and adjustments. With LED bar graph AC data display.

- .7 Engine selector switch for "Off-Auto-Manual" operation. Operation of engine in manual position, when selected, bypasses automatic control system and causes alarm to occur. Switch in "Off" position causes alarm to occur. Switch in either "Off" or "Manual" position causes amber indicator lamp identifying "Not in Auto" to illuminate when alarm occurs.
- .8 Alarm horn with silencing button, and annunciator flashes when audible alarm is silenced until trouble condition cleared and reset.
- .9 Miscellaneous controls including voltage and speed control, emergency stop, fault reset, lamp test, engine start, engine stop and indicating lights.
- .10 Engine alarm and shut down lamps with signals for conditions specified later in this section. Engraved lamicoid identification nameplate provided for each lamp. Lamp test button provided.
- .11 Secondary and Control Wiring: Type "TEW" 105°C rated, extra flexible wire with thermoplastic insulation and overall flame retarding cotton braid, neatly harnessed, suitably secured and identified with slip on identification markers. Wiring colour coded suiting intended applications and standards.
- .12 Factory wired as follows:
 - .1 Wiring for DC supply to control panel, wiring for cranking circuits and wiring for air box damper: Minimum number 10 AWG stranded.
 - .2 Wiring Within Control Panel: Number 16 AWG stranded.
 - .3 Wiring between control panel and engine generator set and transfer switch: No. 14 AWG stranded.
 - .4 Separate junction boxes for AC and DC wiring.
 - .5 Wiring duct for interconnection within panel.
 - .6 Colour coded wiring as follows:
 - .1 Blue: DC control.
 - .2 Red: AC control.
 - .3 Black: PT secondary connections.
 - .4 Orange: CT secondary connections.
 - .5 Green: Non-current carrying ground.
 - .6 White: Current carrying ground.
 - .7 Yellow: Interlocks.
 - .8 Brown: Generator excitation system.
 - .7 Code wiring at each wire end with permanent, non-aging slip on markers. Support and run wiring neatly. Protect wiring from mechanical damage with grommets and shields.
 - .8 Terminal Blocks:
 - .1 Clamp type, serrated for positive grip and of tough, non-brittle, unbreakable nylon.
 - .2 For current transformer secondary circuits, provide terminals blocks of dual connector type.
 - .3 Provide test block for current transformer secondary connections.
 - .4 Coded in accordance with genset manufacturer recommendations.
- .13 Supply loose 2 sets of wiring markers for each external wiring connection. Place markers in plastic bag and secured inside panel.

- .14 Ground Fault Relay:
 - .1 Alarms on control panel in event of ground fault on windings of generator.
 - .2 Current sensor mounted in generator connection box, and generator leads pass through zero sequence circuit in connection box.
 - .3 No internal ground connection in generator is permitted.
 - .4 Annunciator light provided on control panel face, indicates operation of this device.
 - .5 Ground fault setting determined by genset manufacturer, suiting intended application.
- .15 Current transformers of appropriate size for local metering.
- .16 Current transformers for electronic governor.
- .17 DC control system with fusing centrally located.
- .18 Potential transformers of types and ratings suiting intended applications.
- .19 Auxiliary contacts on devices allowing for functions in controls system for interconnection to integrated systems.
- .20 Components as noted, and components for interconnections and installation.
- .3 Breakers:
 - .1 General:
 - .1 Ratings and ampacity of breaker: As noted.
 - .2 Moulded Case Breakers: In accordance with Section 26 28 17 - Low Voltage Breakers.
 - .3 In absence of direction, size and ampacity of breaker to suit application based on electrical code requirements and genset manufacturer recommendations.
 - .4 With settings for generator short circuit output, tripping breaker.
 - .5 Include ground fault protection as required for system and as recommended by genset manufacturer. Provide current transformers (CTs), ground fault relays and secondary CT wiring suiting intended applications.
 - .6 Review breaker type with breaker and genset manufacturer, verifying selection suits intended applications. Prior to ordering breaker, review breaker types and settings with Consultant.
 - .2 Main Genset Breakers – Moulded Case Breakers:
 - .1 Fixed mounted and where frame size exceeds 225 A, complete with solid state adjustable trip unit.
 - .2 Solid state trip units:
 - .1 Includes adjustable long, short, instantaneous, time delay and ground fault alarming.
 - .2 Exact settings determined by genset manufacturer to meet specific applications.
 - .3 Load Bank Breakers:
 - .1 Moulded case type, with frame size as main breaker, interconnected to system allowing for connection of load bank during regular testing of genset.

- .2 Interconnected with shunt trip and relays in automatic manner that when load bank breaker is closed and loss of normal power occurs, load bank breaker opens and main genset breaker closes.
- .4 Auxiliary Breakers:
 - .1 Where noted for fire pump: Moulded case type with solid state trip unit.
 - .2 Where noted for auxiliary requirements for associated equipment: Automatic moulded case breaker (typically 30 A-3 P, feeding damper controls and fuel oil pumps).
 - .3 Prior to ordering breakers, review requirements with Consultant.
- .4 Electronic controls monitoring following various engine performance characteristics:
 - .1 Oil and fuel temperature.
 - .2 Timing of engine.
 - .3 Coolant pressure and level.
 - .4 Oil and fuel pressure.
 - .5 Running hours (non-tamper type).
 - .6 Air temperature.
 - .7 Battery voltage.
 - .8 Engine overspeed.
- .5 Provide controls, contacts and annunciation of shutdowns (red) and warnings (amber) alarms for following conditions and conditions in accordance with CSA Standards:
 - .1 High Oil Temperature: Red.
 - .2 High Oil Temperature Warning: Amber.
 - .3 High Coolant Temperature: Red.
 - .4 Low Oil Pressure Warning: Amber.
 - .5 Low Oil Pressure: Red.
 - .6 Overcrank: Red.
 - .7 Overspeed: Red.
 - .8 Over voltage: Red.
 - .9 Low DC voltage: Amber (alarm lamp complete with DC voltage sensor).
 - .10 Cool Down Period: White.
 - .11 Reverse Power: Red.
 - .12 Undervoltage: Red.
 - .13 Low Frequency: Red.
 - .14 High Frequency: Red.
 - .15 Low Coolant Level: Amber.
 - .16 Low Fuel Pressure: Amber.
 - .17 Gas Supply Valves Isolated: Amber.
 - .18 Starting Battery Fault Condition: Amber.
 - .19 Battery Charger Failure: Amber.
 - .20 Emergency Bus Alive: Blue.
 - .21 Generator Bus Alive: Amber.
 - .22 ECS Not In Auto: Amber.
 - .23 Low Engine Temperature: Amber.

- .24 Alarm Silence: Amber.
- .25 Alternator Winding And Bearing High Temperature: Amber.
- .26 Ground Fault: Amber.
- .27 Genset Main Breaker Open: Amber.
- .28 Automatic Transfer Switch In Non-Auto Or Bypass Mode: Amber.
- .29 Remote Emergency Stop Station: Amber.
- .30 Combustion Air Intake Damper Does Not Open To 85% After 30 Seconds: Amber.
- .31 Air Shutdown Damper (If Applicable): Amber.
- .32 Ventilation Dampers Not Open: Amber.
- .33 Loss Of Integrity To Remote Engine Start Signal Circuits: Amber.
- .34 Ancillary building alarms: As required.
- .35 Two spares for future.
- .6 Operating lights, panel mounted:
 - .1 "Normal Power" pilot light.
 - .2 "Emergency Power" pilot light.
 - .3 Green pilot lights for Breaker ON and red pilot lights for Breaker OFF.
- .7 Provide high brilliant cluster type LED's for indicating lights.
- .8 Provide wiring conductors, terminations and ancillary devices, and other requirements to install and connect integrated components and accessories, for applications of power, control, signalling and integration. Provide fire-rated conductors for intruded applications of life safety in accordance with building codes, and for applications as noted.
- .9 Provide contacts, wiring and connections to auxiliary building systems for applications as noted in Part 3, and for connections to remote annunciators.
- .10 Provide components of genset control system and wiring between components functioning as part of this system, in accordance with required CSA and local building code requirements with regards to minimum fire resistance rating provisions.
- .11 Designer/manufacturer of control system is required to:
 - .1 Supply complete design, erection and layout drawings for system, indicating wiring requirements, interfacing or interconnection provisions required to completely integrate controls with all remote apparatus.
 - .2 Assemble, wire and pre-test system components prior to shipment to site. Such tests witnessed by Consultant at Consultant discretion. Document defects and corrections made. Retest system until successful testing.
 - .3 Assist in installation and oversee work to ensure that it meets with specified requirements.
 - .4 In conjunction with Part 3 onsite testing of genset, carry out control system testing and demonstrate its operation as part of emergency power system to satisfaction of Owner, and reviewed with and recommended g Consultant.

2.10 GENSET MOUNTINGS

- .1 Engine flywheel housing is connected rigidly to generator housing with SAE adaptor. Genset units mount on common, heavy duty, stress relieved, fabricated steel baseplate of sufficient strength and rigidity to maintain alignment of engine generator shafts and frames and to protect assembly from stress or strain, during transportation, installation and under operating conditions on suitable level surface. Baseplates are welded construction without bolt on components.
- .2 Obtain torsional approval report of entire assembly from genset manufacturer and submit copies to Consultant. Report also outlines critical speeds of assembly.
- .3 Engine generator feet and baseplate sole plates are machined parallel and true. Shimming of steel type are installed underneath generator feet.
- .4 Assembly fitted with vibration isolators and control console resiliently mounted. Baseplate supported on suitable type adjustable steel vibration isolators suiting intended applications. Isolation efficiency is not less than 95%. Spring type isolators adjustable for levelling and include side snubbers. Review requirements with genset manufacturer.
- .5 Provide sound insulation pads between isolators and concrete base.
- .6 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and genset manufacturer recommendations.

2.11 FINISHES

- .1 Unless otherwise noted, factory finished in manufacturer standard finishes.
- .2 Alternator control cubicle finish matching engine and alternator.
- .3 Review final colour finish with Consultant.
- .4 For each genset, supply 1 litre of touch-up enamel paint.

2.12 ACCESSORIES

- .1 Supply with engine generator set, soldered galvanized steel drip pan and place beneath engine to catch leakage from set.
- .2 Supply tools and spare parts required for normal maintenance and adjustment of genset, including:
 - .1 One complete set of fuel oil filter elements complete with gaskets.
 - .2 One complete set of lubricating oil filter elements complete with gaskets.
 - .3 One complete set of air filters.
 - .4 Two complete sets of spare fuses.
 - .5 One complete set of spare belts.
 - .6 Other parts and tools as recommended by genset vendor.

2.13 TRANSFER SWITCHES

- .1 Refer to Section 26 36 23 - Transfer Switches, for automatic transfer switch requirements.

2.14 EMERGENCY POWER OFF (EPO) PUSHBUTTONS

- .1 Non-Secured Non-Climate-Controlled Areas:
 - .1 Mushroom head, minimum 38 mm diameter, exterior remote mounted emergency power off (EPO) station.

- .2 Hinged framed break glass cover with locking handle operator.
- .3 Wall mounted back box.
- .4 Prior to ordering, review lock operator keyed-to requirements with Consultant.

2.15 REMOTE ANNUNCIATOR PANELS

- .1 Remote annunciator panel provides visual and audible indication of separate alarm or status conditions, based on discrete (relay) inputs or network inputs interconnected to genset control panel.
- .2 Features:
 - .1 CSA certified, and ULC listed and labeled.
 - .2 Visual and audible warnings of up to 20 separate alarm or status conditions in accordance with NFPA and CSA C282, and in addition provides indications for high battery voltage, low battery voltage, loss of normal power to charger.
 - .3 Additional minimum 4 spare lamp zones for future addition of other alarm and status functions. Prior to ordering, review alarm and status conditions with Consultant.
 - .4 Configurable LED colours (red, yellow, or green) and selectable horn operation.
 - .5 Labelling: Field configurable for alarm status and conditions.
 - .6 Alarm horn switchable for annunciation points. Alarm horn (when switched on) sounds for first fault, and all subsequent faults, regardless of whether first fault has been cleared.
 - .7 Alarm silence and lamp test switch.
 - .8 Sealed membrane panel design provides environmental protection for internal components and is easy to clean.
 - .9 Surface-mount type enclosure.

2.16 SOURCE QUALITY CONTROL (FACTORY WITNESS TESTING)

- .1 Genset manufacturer and supplier is responsible for factory testing and onsite testing of genset and ancillary equipment.
- .2 Prior to shipping to site, factory test generator sets including engine, alternator, control panels and accessories, in presence of Consultant (at option of Consultant). Make arrangements for Consultant to be present at witness testing. Notify Consultant, minimum 10 working days in advance of date of factory test.
- .3 Include "out of town" expenses such as transportation, lodging, meals and miscellaneous items, for Owner and Consultant to witness factory testing. Notify Owner and Consultant at least two weeks in advance of tests. Should additional tests be required due to failure to comply with conditions specified in this article, costs (all travel expenses, accommodation if required, plus \$750.00 per day) for Consultant to witness these additional tests are to be borne by genset manufacturer/supplier.
- .4 Test Records Administration Instructions:
 - .1 Prepare blank forms and check sheet with spaces to record data and at top of first sheet record:
 - .1 Date.
 - .2 Generator set serial number.
 - .3 Engine, make, model, serial number.
 - .4 Alternator, make, model, serial number.

- .5 Voltage regulator make and model number.
- .6 Rating of generator set, kW, kVA, V, A, r/min, Hz.
- .2 Mark check sheet and record data on forms, as test proceeds.
- .3 Completed test reports signed by manufacturer authorized testing technician and authorized representative of installation company.
- .5 Tests:
 - .1 100% rated load: Operate set for minimum 4 hours as reviewed with Consultant, taking readings at maximum 30 minutes (reviewed with Consultant) intervals, and record following:
 - .1 Time of reading.
 - .2 Running time.
 - .3 Ambient temp in degrees C.
 - .4 Lube oil pressure in kPa.
 - .5 Lube oil temp in degrees C.
 - .6 Engine coolant temp in degrees C.
 - .7 Exhaust stack temp in degrees C.
 - .8 Alternator Voltage: Phase 1, 2, 3.
 - .9 Alternator Current: Phase 1, 2, 3.
 - .10 Power in kW.
 - .11 Frequency in Hz.
 - .12 Power Factor.
 - .13 Battery charger current in A.
 - .14 Battery voltage.
 - .15 Alternator cooling air outlet temp.
 - .2 After completion of 4 hours run, demonstrate following shut down devices and alarms:
 - .1 Overcranking.
 - .2 Overspeed.
 - .3 High engine temp.
 - .4 Low lube oil pressure.
 - .5 Short circuit.
 - .6 Alternator over voltage.
 - .7 Low battery voltage, or no battery charge.
 - .8 Manual remote emergency stop.
 - .9 High alternator temperature.
 - .3 Install continuous strip chart recorders, recording frequency and voltage variations during load switching procedures. Each load change delayed until steady state conditions exist. Switching increments include:
 - .1 No load to full load to no load.
 - .2 No load to 70% load to no load.
 - .3 No load to 20% load to no load.
 - .4 20% load to 40% load to no load.
 - .5 40% load to 60% load to no load.
 - .6 60% load to 80% load to no load.

- .6 Demonstrate:
 - .1 Automatic starting of set and automatic transfer of load on failure of normal power.
 - .2 Operation of manual bypass switch.
 - .3 Automatic shutdown of engine on resumption of normal power.
 - .4 That battery charger reverts to high rate charge after cranking.
 - .5 Low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.
- .7 Refer to Part 3 for additional requirements.

2.17 ACCEPTABLE PRODUCT MANUFACTURERS/VENDORS

- .1 Selected engine-generator sets to be provided from listed acceptable genset suppliers and be packaged sets that are factory assembled, factory type tested and warranted together.
- .2 Genset Vendors:
 - .1 Cummins Eastern Canada.
 - .2 Toromont Cat.
 - .3 Pritchard (Kohler)
 - .4 WAJAX.
 - .5 GAL Power.
 - .6 Paramount Power.
- .3 Engine Manufacturers:
 - .1 Cummins.
 - .2 Caterpillar.
 - .3 mtu – Rolls-Royce.
 - .4 Ford.
 - .5 GM.
- .4 Alternator Manufacturers:
 - .1 Newage Stamford.
 - .2 Caterpillar.
 - .3 Marathon.
- .5 Starting Batteries:
 - .1 Exide.
 - .2 Delco.
 - .3 Surette.
- .6 Exhaust System Mufflers/Silencers:
 - .1 SMS Silencers.
 - .2 Silex.
 - .3 Vibron.
 - .4 Nelson.
 - .5 Maxim.

3. Execution

3.01 INSTALLATION OF GENSETS WITH ENCLOSURES

- .1 Provide gensets with enclosures as noted. Refer to Section 26 32 40 - Generating Units Enclosures, for enclosure requirements and installation requirements. Perform installation work and coordinate work between trades.

3.02 MAINTENANCE - CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as required by AHJ, as recommended by manufacturer and in accordance with CSA B139 Series.

3.03 IDENTIFICATION AND SIGNAGE

- .1 Provide identification and signage.
- .2 Provide engraved lamicoid nameplate of each control operator, device and indicating light. Prior to ordering, review nomenclature with Consultant.
- .3 Genset CSA certification nameplate: Mounted in clearly visible locations on control panels and generator-alternator units.
- .4 Control Panel:
 - .1 Size 5 unless otherwise noted, nameplates for controls including alternator breakers and program selector switch.
 - .2 Size 3 unless otherwise noted, nameplates for meters, alarms, indicating lights and minor controls.
- .5 Provide ULC listed labels clearly identified for components, in locations in accordance with requirements of AHJ and TSSA.
- .6 Provide warning signage with nomenclature in accordance with requirements of AHJ and reviewed with Consultant.

3.04 FIELD QUALITY CONTROL

- .1 Perform onsite testing and provide information as outlined in sample test sheets appended to end of this Section. Sample sheets are guidelines only. Expand test sheets with additional testing parameters, suiting testing requirements required by Commissioning Agent and as recommended by genset manufacturer.
- .2 Notify Consultant, minimum 10 working days in advance of onsite testing. Under direction and in presence of Consultant and Commissioning Agent, genset manufacturer authorized technician to provide tests at site on genset and associated equipment when installation is complete, but before acceptance of same. Coordinate with distribution system testing company selected for electrical distribution system testing of Section 26 05 70 - Electrical Testing, verifying that genset and associated equipment performs with emergency power distribution system in accordance with requirements of CSA C282 and Section 26 05 70.

- .3 Coordinate and arrange for manufacturer trained mechanic to conduct tests and to make changes and adjustments found necessary by such tests. Repeat tests until defects are corrected and equipment operates as specified. Perform general operational testing and other testing in accordance with CSA C282. Perform full load test, consisting of period(s) of minimum 4 hours continuous operation under full load conditions as reviewed with Consultant. Perform number of periods of testing to successfully demonstrate that genset and associated equipment complies with specified parameters. Perform initial testing with load banks. Perform testing with building loads when reviewed with and recommended by Consultant and Commissioning Agent.
- .4 Perform onsite testing at times acceptable to Consultant and Commissioning Agent. Perform additional testing due to failure of genset to perform to specified standards. Supply variable load banks and connecting cables, sized for 100% capacity of plant, for specified testing procedures.
- .5 Include for onsite presence of license electrician during testing, verification and commissioning Work, to make distribution system changes necessitated by testing. Include for onsite presence of genset supplier controls contractor during testing and commissioning.
- .6 Upon completion of installation of equipment, equipment vendor to inspect installation of each complete equipment assembly and certify in writing to Consultant, acceptance of installation and operations of same. Submit detailed list of deficiencies to Consultant.
- .7 Genset manufacturer to perform onsite visit to inspect, test, perform start-up, and verify installation is in accordance with requirements of Specification.
- .8 Obtain approvals from AHJ including Technical Standards and Safety Authority (TSSA). Submit copies of compliance certificates to Consultant.
- .9 Upon acceptance of gensets, arrange for manufacturer technician to instruct designated user operating personnel, in correct operation and maintenance of plant. Provide USB type flash drive recording of such instruction. Review with Consultant, list of designated personnel for instructions.
- .10 Operational Tests:
 - .1 Following directions are general typical guidelines for testing of gensets and controls. Prior to start of Work, review requirements with Consultant. Additionally, contact genset manufacturer and obtain their recommended testing procedures for specific gensets. Coordinate with genset supplier.
 - .2 Perform test procedures as specified and in accordance with sample test sheets appended to end of Section. Submit reports signed by testing technician, to Consultant using typical sheets and additional supplemental materials.
 - .3 Integrated Testing: In accordance with CAN/ULC S1001. Coordinate work with respective trades and Divisions.
 - .4 Battery Testing:
 - .1 In accordance with battery manufacturer recommendations.
 - .2 Check battery voltage.
 - .3 Float charge battery.
 - .4 Discharge battery at rated load for time as recommended by manufacturer testing procedures.
 - .5 Check battery voltage at terminals.
 - .6 Recharge battery to full charge.
 - .7 Check battery voltage.

- .8 Leave battery in fully charged state.
- .5 Battery Charger Testing:
 - .1 Energize battery charger and operate until battery shows full charge.
 - .2 Discharge battery to full discharge condition.
 - .3 Recharge battery, recording DC voltage and current once per hour for 8 hours. Test battery verifying battery has reached at least 95% full charge. Continue recharging and record DC voltage and current after 12 hours verifying battery has reached full charge.
 - .4 Continue charging till charger changes from equalize rate to float charge rate.
 - .5 Demonstrate that automatic timer controls charging and correctly transfers from equalize to float charge after selected period.
 - .6 Simulate faults demonstrating that alarm lights and audible alarms are performing in accordance with design requirements and manufacturer specifications.
 - .7 At end of tests, with battery in fully charged condition, operate charger on "float" for minimum period of 24 hours verifying stable condition is reached and held.
- .6 With engine in "cold start" condition and emergency load at its normal operating level, simulate power failure by means reviewed with and recommended by Consultant. Do not interrupt services without review with and recommendation by Consultant. Test load that is normally served by emergency power system. Do not use building loads for testing, unless after review with Consultant and recommended by Consultant. Provide variable load banks sized for loads and with overload capacity.
- .7 Continue operational test for 1 hour, after which time, restore normal power and demonstrate that transfer of load and shutdown of emergency generating sets is in accordance with specified requirements.
- .8 Observe and record following:
 - .1 Time delay on start.
 - .2 Cranking time until engine starts and runs.
 - .3 Time required to come up to operating speed.
 - .4 Time required to achieve steady-state condition with transfer switches transferred to emergency position.
 - .5 Voltage, frequency, and amperes at start-up and at observed change in load.
 - .6 Engine oil pressure, water temperature where applicable, and battery change rate at 5 min intervals for first 15 minutes and at 15-minute intervals thereafter.
 - .7 Time delay on retransfer for each transfer switch.
 - .8 Time delay on engine cool down and shutdown.
- .9 Check and test operation of engine starting system, and jacket coolant heaters.
- .11 Full Load Test:
 - .1 Following operational test, subject genset to 4 hours 100% load test.
 - .2 Provide variable load bank for testing.
 - .3 Full load test initiated by method that starts engine and, immediately upon reaching its rated speed, pick up full load in one step.

- .4 Record data for items listed above, at first load acceptance and every 15 minutes thereafter until completion of test period.
- .12 Cycle Crank Test:
 - .1 Prevent engine from running by utilizing method recommended by manufacturer. Place control switch in "run" position to cause engine to crank.
 - .2 Engage engine starting system to provide cranking cycle consisting of:
 - .1 30 seconds of continuous cranking; or
 - .2 three 10 seconds crank attempts separated by 10 seconds rest periods.
 - .3 Repeat crank cycle a second time to demonstrate that batteries have sufficient capacity for total cranking time of 60 seconds.
 - .4 Demonstrate time required to recharge batteries, meeting requirements.
- .13 Safety Shutdown and Alarms:
 - .1 Test gensets using method as recommended by manufacturer and as specified, verifying that safety shutdowns and alarms are fully functional.
- .14 Ventilation:
 - .1 During testing of gensets, demonstrate that sufficient ventilation is provided for gensets, in accordance with requirements of CSA C282.
- .15 Voltage and Frequency:
 - .1 Perform this test in accordance with CSA C282.
- .16 Oil Analysis:
 - .1 Perform this test in accordance with CSA C282.
- .17 Emissions:
 - .1 Perform testing, showing that performance of integrated genset with exhaust system and stack is in accordance with Specification.
 - .2 Include for specialist noise and air emission company to provide testing, equipment and personnel, verifying that complete genset assembly is in accordance with air and noise emissions requirements of Specification and of AHJ. Include acoustical testing, verifying sound levels during operation at full load. Include results in overall test report.

3.05 SAMPLE TESTING FORM

PROJECT:	_____	PROJECT NO:	_____
	_____	DATE:	_____

GENSET VENDOR:	_____		

CONSULTANT:	_____		
LOCATION:	_____		

PRESENT:	_____		

ENGINE DATA:	_____	SERIAL NUMBER:	_____

A UNIT – GENERAL			
B CONTROL PANEL – GENERAL			
C VIBRATION CONTROL			
D START-UP TIME			
	COLD UNIT: _____		
	HOT UNIT: _____		

E SAFETY DEVICES AND TIME DELAY OPERATION			
SHUT-DOWN OPERATION	ALARM	BELL	LIGHT
LOW OIL PRESSURE			
HIGH COOLANT TEMP.			
OVERSPEED			
OVERCRANK			
OTHERS			
SHUT-DOWN TIME DELAY	4 MIN. AFTER NORMAL POWER RESTORED		
F HOUR METER READINGS			
START: _____			
CONCLUSION: _____			
G RECORDING INSTRUMENTS (SPEED OF CHART)			
1. VOLTAGE (REGULATOR)	ALLOWABLE VARIATION:	_____	
	ACTUAL VARIATION @ 0-1/4 LOAD =	_____	
	ACTUAL VARIATION @ 0-1/2 LOAD =	_____	
	ACTUAL VARIATION @ 0-3/4 LOAD =	_____	
	ACTUAL VARIATION @ 0-1/1 LOAD =	_____	
2. FREQUENCY (GOVERNOR)	ALLOWABLE VARIATION:	_____	
	ACTUAL VARIATION @ 0-1/4 LOAD =	_____	
	ACTUAL VARIATION @ 0-1/2 LOAD =	_____	
	ACTUAL VARIATION @ 0-3/4 LOAD =	_____	
	ACTUAL VARIATION @ 0-1/1 LOAD =	_____	
3. RECOVERY TIME	_____		
H VOLTAGE ADJUSTMENT (SPECIFY):			
I EXHAUST PRESSURE:			

J GENERAL OBSERVATIONS:

K INCOMPLETE ITEMS AND/OR DEFICIENCIES:

L METHOD OF LOADING (SPECIFY):

TIME IN MINUTES:

LOADING

AMPS – PHASE 1

AMPS – PHASE 2

AMPS – PHASE 3

VOLTS – PHASE 1

VOLTS – PHASE 2

VOLTS – PHASE 3

FREQUENCY (HZ)

OIL PRESS. (PSI)

OIL TEMP. (°C)

WATER IN TEMP. (°C)

WATER OUT TEMP. (°C)

JACKET TEMP. (°C)

EXHAUST. TEMP. (°C)

ENGINE SPEED (RPM.)

CHARGER

POWER FACTOR

GENERATOR TEMP. (°C)

ROOM TEMP. (°C)

EXHAUST SMOKE

KW. RATING

VACUUM (GAS UNITS ONLY)

TESTING TECHNICIAN NAME

WSP WITNESS NAME

SIGNATURE

SIGNATURE

DATE: _____

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American Society for Testing Materials (ASTM):
 - .1 ASTM A653/A653M-[20], Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .1 CSA B149.1-[20], Natural Gas and Propane Installation Code.
 - .2 CSA C22.2 No. 30-[20], Explosion-proof Equipment.
 - .3 CAN/CSA-C22.2 No. 61010-1-[12(R2017)], Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements (Tri-national Standard, with UL 61010-1 and ANSI/ISA-61010-1 (82.02.01))
 - .4 CSA C282-[19], Emergency Electrical Power Supply for Buildings.
- .2 Government of Ontario:
 - .1 O. Reg. 524/98-2021, Environmental Compliance Approvals - Exemptions from Section 9 of the Act, under Environmental Protection Act, R.S.O. 1990, c. E.19.
- .3 Technical Standards and Safety Authority (TSSA).
- .4 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S601-[2014-REV1], Standard for Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids.
 - .2 ANSI/CAN/UL/ULC 842, [2020] Standard for Valves for Flammable and Combustible Liquids.

1.02 SUBMITTALS

- .1 Coordinate submittal requirements with respective generator unit Section 26 32 14 - Natural Gas Electric Generating Units.
- .2 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Submit final enclosure design and layout drawings, and structural base drawings stamped and signed by Professional Engineer.
 - .4 Submit shop drawings for products of this Section.
 - .5 Include:
 - .1 Exhaust silencer.
 - .2 Ventilation system.
 - .3 Exhaust system.
 - .4 Other enclosure components.
 - .5 General outline of enclosure incorporated with drawing outline identified for genset assembly shop drawings specified in respective generator units Sections, as applicable, showing:

- .1 Fuel tank (as applicable), exhaust silencer and other components specified.
- .2 Gas piping and valves (as applicable).
- .3 Horizontal and vertical dimensions.
- .4 Locations of components.
- .6 System schematic and wiring diagrams.
- .7 Complete bill of materials, including manufacturer names, catalogue numbers and capacities.
- .3 Submit certification letter certifying factory testing acoustical performance of enclosure housed genset.
- .4 Submit compliance certificates, and testing and verification reports.

1.03 REGULATORY REQUIREMENTS

- .1 Noise and Emissions: In accordance with O. Reg. 524/98.
- .2 In accordance with Technical Standards and Safety Authority (TSSA) requirements.

1.04 DELIVERY, STORAGE AND HANDLING

- .1 Coordinate delivery, storage and handling requirements with genset in accordance with respective generator unit Section.

2. Products

2.01 GENERAL

- .1 Construct, install and test enclosures in accordance with requirements of following:
 - .1 Referenced standards.
 - .2 Building codes.
 - .3 Electrical codes.
 - .4 National Fire Protection Association (NFPA).
 - .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .6 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE).
 - .7 Technical Standards and Safety Authority (TSSA).
 - .8 AHJ.
- .2 Materials of construction to be to general accepted trade standards unless more stringent requirements are required by recent codes or regulations by AHJ.
- .3 Obtain and submit compliance certificates from AHJ.
- .4 Provide supports and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and genset/enclosure manufacturer recommendations.

2.02 GENSET ENCLOSURE (SKIN-TIGHT) – GENERAL FEATURES

- .1 "Skin-tight" type genset enclosure: Houses genset with silencers, control panel, batteries and accessories. General features include:

- .1 Outdoor, weatherproof, corrosion-resistant.
- .2 Sound attenuated.
- .3 Non-combustible fire-rated construction designed in accordance with requirements of AHJ, building codes and CSA C282.
- .4 Heavy duty aluminium or steel outer skin over heavy-duty steel framework construction and primed and finished with corrosion-resistant paint finish.
- .5 Sound insulated panels.
- .6 Exhaust silencer and exhaust piping.
- .7 Locking access panels.
- .8 Flexible coolant and lubricating oil drain lines, that extend to exterior of enclosure, with internal drain valves.
- .9 External radiator fill provision.
- .10 Radiator guard.
- .11 Heavy duty steel beam mounting base.
- .12 Insulated ventilation louvers and dampers.
- .13 Insulated enclosure with non-hygroscopic materials.
- .14 Pitched roof, or other suitable provisions such that precipitation falling on roof does not drain over access doors.
- .15 Corrosion resistant stainless-steel door hardware, hinges and locks.
- .16 Locking compartments for storage of manuals, spare parts and tools.
- .17 Warning signs.
- .18 Vandal-proof construction.
- .19 Finish painted in colour as approved by Owner and reviewed with Consultant.
- .20 Electrical Distribution:
 - .1 Dry type distribution transformer and breaker panelboard, sized to accommodate loads of enclosure components requiring power feeds.
 - .2 Panelboards:
 - .1 120/208 VAC with main automatic breakers and branch breakers for feeding genset and enclosure components and accessories.
 - .2 Factory prewired moulded case breakers.
 - .3 Include 3 additional spare 15A-1P breakers installed in panel.
 - .4 Panel schedule is based on typical requirements. Size panel minimally with sufficient circuits and breakers to accommodate final enclosure requirements including spare breakers and spaces.
 - .3 Emergency Power Off (EPO) Stations:
 - .1 Minimum 38 mm diameter mushroom head, mounted in weatherproof enclosure with break glass cover for emergency access and locking operator for authorized access.
 - .2 Mount recessed or semi-recessed in exterior wall of enclosure, as noted.
 - .3 Lock operator keyed to requirements reviewed with Consultant.
 - .4 "EMERGENCY POWER OFF" identification lettering. Prior to ordering, review requirements and nomenclature with Consultant.

- .21 Minimum 2 - 15/20A 120 VAC GFCI receptacles inside enclosure, and weatherproof-in-use GFCI receptacle on outside of enclosure. Connect each receptacle to separate dedicated circuit.
- .22 Switches controlling AC powered LED lamps mounted in vapour tight and gasketed internal fixtures, controlled with 60 minutes adjustable timer.
- .23 Switched controlled vapour tight, gasketed DC light connected to main batteries, controlled with 60 minutes adjustable timer.
- .24 External AC weatherproof and vandal proof LED type fixture with photocell control over main panel access door.
- .25 Thermostatically controlled forced air internal heater, maintaining interior temperature at minimum temperature in accordance with CSA C282.
- .26 Exhaust fan for internal high temperature heat removal from enclosure and include modulating thermostat control.
- .27 Fuel tank: For diesel gensets as noted.
- .28 Storage cabinet for operating and maintenance manuals and spare parts.
- .2 Seismic restraints as specified.
- .3 Design enclosure with structural framing for intended application including mounting on concrete structural slab or rooftop structure. Professional Engineer to review and endorse design of enclosure base structural steel members and overall enclosure structural design.
- .4 Enclosure Features:
 - .1 Overall exterior enclosure construction of galvanized steel or aluminum.
 - .2 In applications of use of dissimilar materials, include provisions preventing corrosion.
 - .3 Slope roof directs precipitation landing on roof in direction as noted, and reviewed with Consultant.
 - .4 Designed such that genset components needing routine maintenance and servicing or replacement are easily accessible from access doors.
 - .5 Access doors are locking, hinged type with retainers holding doors open during service.
 - .6 Rooftop enclosures with fuel tanks include access doors/panels sized accommodating passage of fuel tanks.
 - .7 Intake and exhaust louvers located at height minimizing effects from flood waters and accumulated snow levels.
 - .8 No roof penetrations. Review with and obtain recommendations for acceptance from Consultant, for exhaust stack penetrations.
 - .9 Motorized intake louvers minimize air flow through enclosure when generator set is not operating. Louvers include provisions preventing accumulation of ice or snow that might prevent operation. Louvers are spring open, power close operation, in accordance with AHJ.
 - .10 Weatherproof cable stub and openings for connection cabling through underside of base.
 - .11 Load bank cabling entry, temporary genset connections, communications and control wiring via openings with flexible boots behind gasketed locking hinged door. Boots prevent ingress of precipitation into enclosure when cables are run into enclosure.
 - .12 Exterior components and parts are corrosion-resistant and weatherproof.

- .13 Location of cable access openings coordinated suiting structural base.
- .14 Cable connection box with copper bussing.
- .15 Materials of construction: In accordance with general accepted trade standards unless more stringent requirements are required by AHJ.

2.03 ACOUSTICS

- .1 Sound Emissions: Maximum permissible sound emissions criteria for enclosure at engine full load rating are as noted, or where not noted, rating is net 72 dBA at 7 m including provisions for reverberations from neighbouring walls.
- .2 Sound-attenuated housing rated allowing genset to operate at full rated load in ambient temperature of up to 40°C.
- .3 Coordinate selection of silencer (muffler) with design of enclosure in accordance with sound level requirements.
- .4 Submit with shop drawings, certification letter from recognized acoustical authority certifying factory testing acoustical performance of enclosure housed genset, with genset operating at full load rating in accordance with specification requirements.
- .5 Provide qualified acoustical engineer to perform acoustical field test during onsite genset testing, to certify performance and provide documented test report. Measure noise levels at 10 different locations as reviewed with Consultant.
- .6 Obtain and submit required compliance certificates.

2.04 EXHAUST SYSTEM

- .1 Engine Exhaust System Features:
 - .1 Full factory installed within enclosure, consisting of lengths of flexible stainless-steel exhaust pipe, flange, mounting brackets, and exhaust silencers with drain plug and accessories.
 - .2 Size length of flexible piping for thermal expansion and engine vibration and suiting enclosure height restriction.
 - .3 Silencers:
 - .1 Provide high degree of noise reduction, with final selection suiting respective size of genset and coordinated with enclosure design suiting spacing and overall noise criteria.
 - .2 Corrosion-resistant construction.
 - .3 Mild carbon steel construction, unless otherwise noted.
 - .4 Stainless steel construction where noted.
 - .5 Include drain plug and other accessories for connection and installation.
 - .4 Flexible pipe and silencer suiting intended applications and as recommended by genset supplier.
 - .5 Custom manufactured, heavy duty steel exhaust flange extends from silencer to roof thimble.
 - .6 Exhaust piping exhausts out of enclosure roof through insulated roof thimble designed for intended application and with weatherproof sealed prefabricated flashed roof curb. Thimble of heavy-duty galvanized steel corrosion-resistant construction.
 - .7 Where required suiting exhaust configuration of respective gensets, provide properly sized black steel pipe welded "Y" connector.

- .2 Exhaust Piping and Stack:
 - .1 In accordance with AHJ.
 - .2 Terminate exhaust pipe flange minimum 450 mm above roof line and top with required temporary weatherproof cap. Provide exhaust stack stub assembly capable of supporting onsite installation of vertical exhaust stack up to 3 m high unless otherwise noted.
 - .3 Insulate interior exhaust piping with minimum 50 mm thick rock-based fire-rated mineral fiber type insulation suiting intended application.
 - .4 Exterior Vertical Exhaust Stack:
 - .1 Provide exhaust stack of height in accordance with AHJ air and noise approval criteria as reviewed with Consultant. Where exhaust stack is provided, provide guy wires for proper support and secure to structure.
 - .2 Constructed of minimum schedule 40 rigid black steel, or double wall construction stainless steel chimneys. Diameter suiting genset sizing and reviewed with genset manufacturer.
 - .3 Design and layout prevents ingress of water and snow backing into silencer and with means reviewed with Consultant to drain accumulation in exhaust piping away from enclosure.
 - .4 Exhaust stack in position designed to withstand anticipated wind forces and other forces of nature. Provide supports and guy wiring in accordance with stack manufacturer and encloser manufacturer recommendations.
- .3 Coordinate routing, dimensions, and configuration of exhaust system with enclosure dimension restrictions and equipment layout as detailed.
- .4 Position exhaust stack in location such that emissions do not become drawn into enclosure during operation. Weatherproof and seal openings in roof due to exhaust stack work.

2.05 FIRE ALARM, SECURITY AND COMMUNICATIONS PROVISIONS

- .1 Provide enclosure with provisions of empty conduits with fish cord and electrical boxes for installation of security devices, fire alarm detectors, initiating devices, visual devices, audible devices and communication devices, provided by main building respective system vendors. Coordinate work with respective vendors.
- .2 Provide fire alarm device conduit runs to allow for Class A looped running of system wiring, extending from device boxes to termination box near enclosure wall, easily accessible for extension to main building. Provide separate conduit loop runs for each of initiating devices and for indicating devices.
- .3 Fire Extinguishers: CO2 type, no less than 4.5 kg, and mounted within enclosure. Exact type of fire extinguisher as recommended by genset vendor suiting intended applications. Provide mounting bracket and install on interior wall adjacent door. Include identification label on outside of door identifying location of extinguisher.

2.06 ACCESS AND SECURITY SIGNS, AND NAMEPLATES/LABELING

- .1 Provide identification painting, engraved lamicaid nameplates, labelling, warning signage and access and security signage, as reviewed with Consultant. Identify each component on panels, piping, conduits, and other components.
- .2 Provide ULC listed identification labels clearly identifying components in locations, in accordance with AHJ.

- .3 Provide signage as follows:
 - .1 Corrosion-resistant, weather-resistant and resistant to fading from sunshine.
 - .2 Red lettering on white background, unless otherwise noted.
 - .3 Permanently affixed.
 - .4 Colours, print size and nomenclature reviewed with Consultant prior to manufacturer. Generally, to read as follows:
 - .1 Exterior: "AUTHORIZED PERSONNEL ONLY".
 - .2 Above Genset: "WARNING – KEEP OFF – GENSET MAY START AUTOMATICALLY AT ANY MOMENT".

2.07 LIGHTNING PROTECTION SYSTEM COMPONENTS

- .1 Provide lightning system components as extension of main building lightning protection system. Extend system to cover enclosure roofs and exhaust system stack. Include for:
 - .1 16 mm diameter solid copper air terminals; of lengths suiting intended application.
 - .2 25 mm x No. 17 gauge copper grounding straps.
 - .3 Braided stranded copper "lightning conductor" down lead conductors.
 - .4 Not less than 20 mm diameter and not less than 3 m long (sectionalized 1.2 m lengths) circular cross section copper bond type ground rods.
 - .5 Inspection pit with test coupling, earth equipotential bar, die cast brass connectors, die cast brass clamps and ground rods.
 - .6 No Penetrations of Enclosure: Supplemental weatherproof and corrosion resistant structural steel supports and channels provided on enclosure and utilized for fastening and securing components to enclosure without penetrating enclosure.
 - .7 Ancillary devices for connection and installation of system.

2.08 PLATFORMS, STAIRS AND RAILINGS

- .1 Provide safety grating walkways, platforms and stairs, with reticulated and formed metal cross struts, and hand railing for enclosures, as noted.
- .2 System of safety grating type with following features:
 - .1 In accordance with AHJ.
 - .2 Rust-resisting materials and finishes.
 - .3 Pre-galvanized steel to ASTM A653/A653M; 12 gauge, hot rolled, pickled and oiled, commercial quality black steel and commercial quality, commercial coating, chemically treated galvanized steel, or hot dipped galvanized after fabrication.
 - .4 Non-slip surface with openings small enough to catch falling tools and other dangerous objects.
 - .5 Open design permits convenient access for cleaning and quick drainage of fluids, chips, grease and mud. Ice accumulation shears easily under normal foot pressure.
 - .6 Bridged struts with integral side channels form plank that can support loads with minimum transverse and longitudinal deflection.
 - .7 No rivets or pressure joints to break or loosen.
- .3 Complete assemblies include following grip strut materials:

- .1 Grating sized for areas.
- .2 Grating fastening anchor accessories.
- .3 Walkway splice plate kits and accessories kits.
- .4 Non-slip stair treads of 10 gauge galvanized steel construction. Typically, minimum 50 mm depth, 350 mm widths, and spans suiting design requirements.
- .5 Hand railing brackets of type suiting posts.
- .6 Handrails, balustrades and posts: Heavy duty 40 mm diameter steel pipe with powder-coated safety yellow enamel corrosion-resistant outdoor finish.
- .7 Mounting hardware and ancillary devices for connection and installation of assemblies.

2.09 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Genset Enclosures:
 - .1 Provided by and as recommended by genset vendors/suppliers.
- .2 Electrical Distribution Products:
 - .1 Eaton.
 - .2 Schneider.
 - .3 Siemens.
- .3 Exhaust System Mufflers/Silencers:
 - .1 SMS Silencers.
 - .2 Silex.
 - .3 Vibron.
 - .4 Nelson.
 - .5 Maxim.
- .4 Ventilation Silencers:
 - .1 Vibro-Acoustics.
 - .2 Price.
 - .3 Kinetics Noise Control.
- .5 Dampers and Louvres:
 - .1 Nailor.
 - .2 T. A. Morrison.
 - .3 Greenheck.
 - .4 NCA Manufacturing.
 - .5 Ruskin.

3. Execution

3.01 INSTALLATION OF GENSET AND ENCLOSURES

- .1 Prior to start of Work, prepare schedule of Work and submit to Consultant. Manufacturer or supplier to upon successful factory witness testing of unit, arrange and coordinate delivery and transporting of units to site.

SPECNOTE: *In following, reference appropriate section. Edit as required.*

- .2 Provide genset and enclosure as specified and detailed. Refer to generating units Section 26 32 14 - Natural Gas Electric Generating Units, as applicable, for genset requirements.
- .3 Prepare and submit with shop drawings, necessary design, erection and layout drawings, wiring, piping and control diagrams for execution and completion of Work.
- .4 Coordinate controls work both at factory and on site and include for interface work to equipment on site.
- .5 Perform testing, start-up and verification work as specified, and specified in respective generating units Section.
- .6 Provide transporting and hoisting of gensets and enclosures to locate into position. Coordinate responsibility and requirements with respective trades.
- .7 Provide components and installation work in factory as specified.
- .8 For on grade Installations: Coordinate structural base requirements for mounting of containerized genset with respective trades. Provide concrete pad as detailed on drawings, typically of dimensions covering size of genset enclosure and extending minimum 600 mm beyond each side, and of depth to accommodate weight of entire unit with full loaded fuel.
- .9 Rooftop Installations: Coordinate structural requirements with general trades work with regards to providing structural roofing work accommodating unit installations.
- .10 Install units plumb and level. Provide vibration isolation and seismic restraints as specified. Secure genset on vibration isolation springs to its base by means of 13 mm diameter high tensile strength steel anchor bolts. Check engine generator alignment when mounting is complete. Realign where necessary, in accordance with manufacturer recommendations.
- .11 Provide shore power feeders in conduit from dedicated breakers in panelboards in main building, serving container genset, and connect to integral power panel and devices. Connect feeders to panel feeding components and accessories. Identify breakers in panel. Make connections to genset with suitable cabling and lugs. Refer to notes on drawings. Provide distribution equipment to general standards of electrical products specified in other Sections.
- .12 Connect power wiring to building distribution system, as reviewed with Consultant.
- .13 Exterior Feeders: RWU90 in surface rigid galvanized steel conduit, or in rigid PVC underground. Coordinate conductor and conduit runs with genset vendor to suit enclosure requirements.
- .14 For initiating start-up upon loss of normal power of electrical distribution system, provide fire rated MI wiring from genset control panel to appropriate transfer switch contacts or to other designated loss of normal power signal as reviewed with Consultant, to initialize engine start-up upon loss of normal power.
- .15 Fill radiator with a solution of 50% clean water and 50% permanent type ethylene glycol (exact ratio in accordance with requirements of with genset manufacturer). Check specific gravity of engine coolant. Add glycol and/or water, as required.
- .16 Check level of engine lubricating oil and add as required. Check and test operation of engine starting system, and jacket coolant heaters. Include acoustical testing to verify sound levels during operation at full load.
- .17 Make conduit connections to genset with liquid tight flexible conduits.

- .18 Provide exhaust stack extension and mount to enclosure in accordance with genset supplier instructions. Secure with supports and guy wires, as required. Provide lightning protection air terminal, down conductors and extend to grade ground rod driven into grade, as specified.
- .19 Provide grounding and bonding conductor system with ground bar in enclosure for common connection of grounding and bonding conductors from equipment to exterior ground rods or connection to main building grounding system. Refer to drawing requirements.
- .20 Install lightning protection system components and wiring as noted. Connect air terminal system to main building lightning protection system or to down conductors connecting to grade ground rod. Refer to drawing details.
- .21 Connections to Main Building Systems:
 - .1 Provide and connect control panel wiring extended to terminal box of enclosure, for fire alarm system, security system and BAS interconnections, as reviewed with Consultant. Include for interconnections from generator control panel to fire alarm system and BAS control panels for supervision and annunciation of "Main Breaker Open", "Generator Running", "Generator Failure to Start", "Low Voltage Generator Battery" and "Low Fuel Level/Pressure" and others as required by AHJ.
 - .2 Coordinate and arrange for main building fire alarm system vendor and security system vendor to provide respective system devices, wiring and connections. Extend circuits from common terminal box in genset enclosure to main building and arrange for respective system vendors to connect to respective main building systems to annunciate specified separate zones/points. Provide wiring and conduit of type to suit application in accordance with codes and as recommended by system manufacturer.
 - .3 Coordinate additional points and connections with requirements specified in generator unit section.
 - .4 Provide low voltage relays, wiring in conduit and contactors as required.
- .22 Seal enclosure openings for cables, piping, conduits and other penetrations after installation, with watertight firestopping and smoke seal materials.
- .23 Coordinate required fuel oil connections (supply piping and control/monitoring wiring) with Mechanical Division Contractor to ensure proper fuel feed to genset and monitoring of fuel level. Coordinate provision of work verify compliance with CSA B139 Series.
- .24 Coordinate natural gas piping connections and alarm connections with Mechanical Division Contractor and verify proper installation is made to supply fuel to genset. Coordinate provision of work verifying compliance with CSA B149.1.
- .25 Provide connection to gas isolation valves at incoming gas supply on main building; to follow route of gas line; and indicate alarm when valves are isolated preventing gas supply.
- .26 Where noted, provide concrete bollards. Coordinate provision of concrete work, and excavation and backfilling work with respective general trades.

3.02 INSTALLATION WORK FOR PLATFORMS, STAIRS AND RAILINGS

- .1 Coordinate work with respective various trades.
- .2 For on grade installations, prepare ground for structural supports and install supporting entire assembly and anticipated loads.

- .3 Install work according to manufacturer recommendations.
- .4 Position grating sections flat and square with ends on supporting structure.
- .5 Maintain clearances of sections and joints.
- .6 Band random cut ends and diagonal or circular cut exposed edges with minimum 3 mm thick bar welded at contact points.
- .7 Join abutting sections with manufacturer supplied splice plates, bolted or welded in accordance with manufacturer instructions.
- .8 Install steps, handrail brackets, posts and rails.
- .9 Weld connections where possible, otherwise bolt connections. Countersink exposed fastenings cut off bolts flush with nuts. Make exposed connections of same material, colour and finish as base material on which they occur. Grind or file exposed welds and steel sections smooth.
- .10 Clean assemblies. Touch-up surfaces to new appearance.

3.03 MAINTENANCE - CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as required by AHJ, as recommended by manufacturer and in accordance with CSA Standards.

3.04 FIELD QUALITY CONTROL

- .1 Testing, Start-Up and Verification by Manufacturer Technician:
 - .1 Perform factory testing as integrated with factory witness testing of gensets. Test equipment and systems and verify proper operation. Document testing and results in reports signed by genset enclosure manufacturer authorized technician.
 - .2 Perform onsite after installation inspection, testing, start-up, and verification integrated with genset testing, start-up, and verification work. Assist installing Contractor in installation of equipment and to inspect installation, test equipment, perform start-up and verify equipment. Coordinate work with installing Contractor. Document testing and results in reports signed by genset enclosure manufacturer authorized technician.
 - .3 Be present to assist during onsite third-party testing and commissioning.
- .2 Inspection, Start-up, Testing and Verification:
 - .1 Test and verify functions of enclosure with specified genset testing.
 - .2 Inspect, start-up, test and verify products.
 - .3 Check connections and operations.
 - .4 Test exhaust system piping pressures.
 - .5 Test complete enclosure operation with testing of gensets.
- .3 Obtain approvals and compliance certificates. Submit copies with reports.
- .4 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C282-[19], Emergency Electrical Power Supply for Buildings.
- .2 Standards Council of Canada/Underwriters Laboratories of Canada (CAN/ULC):
 - .1 CAN/ULC-S601-[2014-REV1] , Standard for Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include:
 - .1 Engine generator set (genset) with accessories.
 - .2 Genset control panel and related controls.
 - .3 Integration drawings identifying various integration points of other systems of building.
 - .4 Full design detail drawings and layouts.
 - .5 Wiring schematics.
 - .6 Dimensions of set and associated major components.
 - .7 Electrical characteristics.
 - .8 Power data.
 - .9 Fuel consumption data.
 - .10 Point-by-point description of control system software sequence of operation.
 - .11 Certificate/test report that genset is in proper working condition.
- .3 Submit detailed proposal drawing identifying proposed route of cable runs, location of temporary genset, and proposed equipment.
- .4 Submit testing and verification reports.

1.03 SPARE PARTS

- .1 Supply following spare parts:
 - .1 One complete set of spare fuses.
 - .2 One complete set of spare belts.

2. Products

2.01 TEMPORARY GENSETS

- .1 Provide prime rated temporary generator set (genset) complete with connection cables to site for purposes of providing power to connected building loads during Work. Engage rental service company to provide rental genset and related work.
- .2 Onsite Duration for Gensets: From cutover time that existing genset or control system is offline and not available to provide power to emergency power distribution system, until replacement genset and work to emergency power distribution system is complete and commissioned, fully operable and available to provide power to distribution system.
- .3 Obtain from company supplying temporary genset, certificate verifying that supplied temporary genset is 100% load tested, is in full proper working order and is serviced, and all verified and certified within 14 days prior to shipping to site. Submit copy of certificate signed by authorized officer of rental company. Refer to drawing notes and Part 3 for additional requirements.
- .4 Gensets include main breakers in accordance with requirements of AHJ, and controls and monitoring in accordance with CSA C282 requirements. Include breakers for connecting auxiliary load banks for testing.
- .5 Provide temporary control equipment, automatic transfer switch and switchgear to interconnect temporary genset to emergency power system such that temporary genset is connected to system automatically to feed loads in accordance with emergency power control system sequence of operations. Provide interlock components and scheme preventing accidental failure of allowing more than one power source at once connected to emergency power distribution system. Review existing system sequence of operations and requirements onsite and confirm with Owner and review with Consultant. Include control software, load shedding, synchronization and paralleling components, suiting system sequence of operations and maintaining existing sequence, unless otherwise noted.
- .6 Electronic controls monitor various engine performance characteristics including, but not limited to, following:
 - .1 Start/stop signal.
 - .2 Genset running.
 - .3 Common trouble.
 - .4 Overcrank.
 - .5 Low engine temperatures.
 - .6 High engine temperature pre-alarm.
 - .7 High engine temperature.
 - .8 Low lube oil temperature.
 - .9 Overspeed.
 - .10 Main breaker open.
 - .11 Control switch not in automatic position.
 - .12 Low fuel.
 - .13 Fuel temperature.
 - .14 Low voltage in battery.
 - .15 Audible alarm silencing switch.
 - .16 Auxiliary supply tank containment leak sensing.
 - .17 Coolant pressure and level.
 - .18 Running hours.

- .7 Provide cables and connections for shore power provisions of genset. Include power connections for battery charger and unit heaters. Coordinate building connection shore power supply points with Owner building manager and review with Consultant.
- .8 Provide 2-hour fire-rated type MI cables for genset control, monitoring and power requirements, in accordance with requirements of AHJ and codes.
- .9 Refer to drawings for size of genset and electrical characteristics. Locate unit outside of building in location as approved by Owner and reviewed with Consultant.
- .10 Perform loading, unloading, running and installation of temporary cabling from temporary generator location to distribution system connection point. Stabilize and secure unit in place. Mechanically protect temporary connection cable by means approved by Owner and reviewed with Consultant. Provide safety barriers and safety warning signs. Provide components to connect temporary genset to existing distribution system such that existing sequence of operation is maintained, as approved by Owner and reviewed with Consultant.
- .11 Provide type of conductors, terminations and ancillary devices, and other requirements necessary for installation and connection of integrated components and accessories, in accordance with requirements of genset vendor, building codes and AHJ. Applications include for power, control, signalling, integration, lighting and security. Confirm requirements with genset vendor.
- .12 After completion of Work, perform disconnections and removals of temporary installations. Patch surfaces and openings, matching existing standards, and approval of Owner.
- .13 Rental service company genset technicians to provide technical assistance and assist in adjustments of controls, fuel and air systems during genset testing and operation. Supply licensed electrician onsite for testing, verification and commissioning work, and to make distribution system changes necessitated by Work. Rental service company controls technician to perform onsite testing and commissioning Work.
- .14 Include in enclosure CSA certified, CAN/ULC-S601 listed and labeled sub-base fuel tank. Provide double-walled, steel construction fuel tank and include following features:
 - .1 Enough fuel capacity to operate genset for anticipated duration of Work, under full load nameplate rating. Identify amount of fuel with shop drawing submittals.
 - .2 Mechanical fuel level gauge.
 - .3 Leak detection provisions wired to generator set control for local and remote alarm indication.
- .15 Include costs and expense associated with use of temporary genset, including maintenance and fuel oil for regular testing, in accordance with CSA testing requirements and Owner requirements. Include sufficient fuel and perform maintenance during use of genset during work.
- .16 House temporary genset in secured outdoor weatherproof and sound-attenuated enclosure with locked access doors.
- .17 Provide temporary chain link fencing and access gate with padlocking provisions, around perimeter of temporary genset. Provide fencing of minimum 1.2 m high and complete with support posts, hardware, and warning signage. Confirm requirements with Owner and review with Consultant.

3. Execution

3.01 INSTALLATION OF TEMPORARY GENSET

- .1 Turn over copy of rental company certificate confirming successful testing and servicing of genset prior to setting into position.
- .2 Prepare detailed proposal drawing identifying proposed route of cable runs, location of temporary genset, and proposed equipment and proposed sequence of operation. Submit proposal for Owner approval and review with Consultant. Refer to notes on drawings.
- .3 Provide and locate temporary genset in location as reviewed with Consultant.
- .4 Provide cables for genset output load connections, genset accessories connections, controls connections, communications connections and auxiliary connections suiting intended applications.
- .5 Connect temporary cables and run in location and in routing approved by Owner and reviewed with Consultant. Mechanically protect cables and provide warning signs and install cabling allowing unobstructed and safe pedestrian/vehicular traffic throughway.
- .6 Ground and bond equipment.
- .7 Install safety and protective equipment and signage.

3.02 FIELD QUALITY CONTROL

- .1 After installation is complete and connections are made, perform basic start-up test of genset with Consultant and Owner present.
- .2 Under direction of Owner and recommendations from Consultant, perform testing of temporary genset under variable load conditions as later directed onsite.
- .3 Allow for minimum 2 hours of testing under conditions as reviewed with Consultant.
- .4 Test control system and integrated system operations. Provide load banks for testing genset at full load and variable loads.
- .5 Refer to attached testing sheets for general requirements.
- .6 Perform testing during times directed by Owner and provide genset technicians, electricians and control personnel onsite during installation and testing.
- .7 At start of Work, record amount of fuel in storage tanks.
- .8 Prepare and sign testing and verification reports. Submit reports to Consultant.
- .9 Instruct designated operating personnel on operating and maintenance procedures.

END OF SECTION

3.03 SAMPLE TESTING FORM

PROJECT:	_____	PROJECT NO:	_____
	_____	DATE:	_____

GENSET VENDOR:	_____		

CONSULTANT:	_____		
LOCATION:	_____		

PRESENT:	_____		

ENGINE DATA:	_____	SERIAL NUMBER:	_____

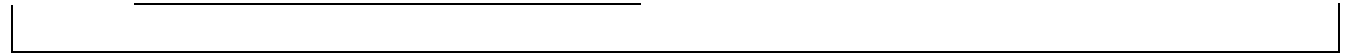
A UNIT – GENERAL			
B CONTROL PANEL – GENERAL			
C VIBRATION CONTROL			
D START-UP TIME			
COLD UNIT: _____			

HOT UNIT:	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div> <div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>		
E SAFETY DEVICES AND TIME DELAY OPERATION			
SHUT-DOWN OPERATION	ALARM	BELL	LIGHT
LOW OIL PRESSURE	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>		
HIGH COOLANT TEMP.	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>		
OVERSPEED	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>		
OVERCRANK	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>		
OTHERS	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>		
SHUT-DOWN TIME DELAY	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%; text-align: center;">4 MIN. AFTER NORMAL POWER RESTORED</div>		
F HOUR METER READINGS			
START:	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>		
CONCLUSION:	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>		
G RECORDING INSTRUMENTS (SPEED OF CHART)			
1. VOLTAGE (REGULATOR)	ALLOWABLE VARIATION:	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>	
	ACTUAL VARIATION @ 0-1/4 LOAD =	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>	
	ACTUAL VARIATION @ 0-1/2 LOAD =	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>	
	ACTUAL VARIATION @ 0-3/4 LOAD =	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>	
	ACTUAL VARIATION @ 0-1/1 LOAD =	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>	
2. FREQUENCY (GOVERNOR)	ALLOWABLE VARIATION:	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>	
	ACTUAL VARIATION @ 0-1/4 LOAD =	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>	
	ACTUAL VARIATION @ 0-1/2 LOAD =	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>	
	ACTUAL VARIATION @ 0-3/4 LOAD =	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>	
	ACTUAL VARIATION @ 0-1/1 LOAD =	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>	
3. RECOVERY TIME	<div style="border-bottom: 1px solid black; height: 1.2em; width: 100%;"></div>		
H VOLTAGE ADJUSTMENT (SPECIFY):			
I EXHAUST PRESSURE:			

J GENERAL OBSERVATIONS:

K INCOMPLETE ITEMS AND/OR DEFICIENCIES:

L METHOD OF LOADING (SPECIFY):	
TIME IN MINUTES:	_____
LOADING	_____
AMPS – PHASE 1	_____
AMPS – PHASE 2	_____
AMPS – PHASE 3	_____
VOLTS – PHASE 1	_____
VOLTS – PHASE 2	_____
VOLTS – PHASE 3	_____
FREQUENCY (HZ)	_____
OIL PRESS. (PSI)	_____
OIL TEMP. (°C)	_____
WATER IN TEMP. (°C)	_____
WATER OUT TEMP. (°C)	_____
JACKET TEMP. (°C)	_____
EXHAUST. TEMP. (°C)	_____
ENGINE SPEED (RPM.)	_____
CHARGER	_____
POWER FACTOR	_____
GENERATOR TEMP. (°C)	_____
ROOM TEMP. (°C)	_____
EXHAUST SMOKE	_____
KW. RATING	_____
OTHER	_____
_____	_____
TESTING TECHNICIAN NAME	WSP WITNESS NAME
_____	_____
SIGNATURE	SIGNATURE
DATE: _____	



1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 107.1-[16(R2021)], Power Conversion Equipment.
 - .2 CSA C22.2 No. 280-[22], Electric Vehicle Supply Equipment (Tri-national Standard, with UL 2594 and NMX-J-677-ANCE-2016).
 - .3 CAN/CSA C22.2 No. 281.1-[12(R2022)], Standard for Safety for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements (Tri-national standard, with UL 2231-1 and NMX-J-668/1-ANCE).
 - .4 CAN/CSA-C22.2 No. 281.2-[12(R2022)], Standard for Safety for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems (Tri-national Standard, with UL 2231-2 and NMX-J-668/2-ANCE).
- .2 Code of Federal Regulations (CFR):
 - .1 CFR Title 47/Chapter I/Subchapter A/Part 15-[2022], Radio Frequency Drives.
- .3 Society of Automotive Engineers (SAE):
 - .1 SAE J1772-[2017], Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section as specified in Part 3.
 - .2 Include:
 - .1 Electrical input and output ratings.
 - .2 Outlet types and quantities.
 - .3 Configurations and mounting.
 - .4 Software features and options.
 - .5 Applicable Measurement Canada approvals.
- .3 Submit copies of applicable approvals, and testing and verification reports.

2. Products

2.01 GENERAL

- .1 Standards:

- .1 Electric vehicle (EV) charging systems designed, manufactured and tested in accordance with following standards:
 - .1 CSA C22.2 No. 107.1.
 - .2 CSA C22.2 No. 280.
 - .3 CAN/CSA C22.2 No. 281.1 and CAN/CSA-C22.2 No. 281.2.
 - .4 CFR Title 47/Chapter I/Subchapter A/Part 15, Class A.
- .2 Stations CSA certified, or ULC listed and labeled.
- .3 Stations based on Level 2 public use electric vehicle charging stations, unless otherwise noted.
- .4 For systems billing for electricity energy usage, provide applicable Measurement Canada approvals of metering devices in accordance with requirements of Measurement Canada.
- .5 Ratings, configurations and mounting details: As noted herein or detailed on drawings.
- .6 Demonstration and Training:
 - .1 System programming.
 - .2 Provide onsite inspection, start-up and testing services.
 - .3 Demonstrate and train designated end users on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.

2.02 STANDARD AC ELECTRIC VEHICLE CHARGING STATIONS

- .1 AC output powered type, Level 2, electric vehicle charging stations with features as follows:
 - .1 Stations: Single or dual station layouts as noted.
 - .2 Integral control software.
 - .3 Enclosures:
 - .1 Integrated power and control cabinet design.
 - .2 NEMA Type 3R, water-resistant and vandal-proof enclosure.
 - .3 Impact resistant thermoplastic.
 - .4 Pre-attached input cable and mounting hardware.
 - .5 Finish: Weather-resistant and corrosion resistant finish in manufacturer standard finish as reviewed with Consultant.
 - .4 Mounting: As noted:
 - .1 Pedestal Mounting Pole (Bollard) and Base:
 - .1 Single or dual mounting with retractable cord management.
 - .2 Direct burial or concrete slab mounted types as required for specific applications.
 - .3 Direct burial mounting foundation constructed of durable, weather-resistant polypropylene.
 - .4 Concrete mounting kit for securing pedestal bases to concrete slabs.
 - .5 Pedestal constructed of durable powder coated steel with weather-resistant and corrosion-resistant finish.
 - .6 Finish: Manufacturer standard finish as reviewed with Consultant.

- .7 Dimensions: Confirm available dimensions are suitable for project as reviewed with Consultant.
- .5 Embedded meter circuit component with 1% (after calibration) accuracy at nominal input, rated output current to measure voltage, current, frequency power, energy at input for internal reference.
- .6 Auto-Reclosure feature enables charging to restart following minor fault, thereby reducing chance of having undercharged battery.
- .7 Ground monitor interrupter circuit for safety.
- .8 Integrated On/Off switch to minimize standby power.
- .9 Status LED indicator lights: Power Present, Charging, Fault.
- .10 Operating Temperature: Minus 30°C to 50°C.
- .11 Charging Connector Cord: Type SAE J1772 connector on 5.5 m long UL Type EV cable.
- .2 Electrical Specifications:
 - .1 32 A Model:
 - .1 Amperage: 30 A, 60 Hz.
 - .2 Breaker: 2 Pole, 40 A Breaker on dedicated circuit, non-GFCI type.
 - .3 Electrical Input: 240 VAC single phase, hardwired.
 - .4 Electrical Output Power: 7.6 kW.
 - .2 48 A Model:
 - .1 Amperage: 48 A, 60 Hz.
 - .2 Breaker: 2 Pole, 60 A Breaker on dedicated circuit, non-GFCI type.
 - .3 Electrical Input: 240 VAC single phase, hardwired.
 - .4 Electrical Output Power: 11.6 kW.
 - .3 80 A Model:
 - .1 Amperage: 80 A, 60 Hz.
 - .2 Breaker: 2 Pole, 100 A Breaker on dedicated circuit, non-GFCI type.
 - .3 Electrical Input: 240 VAC single phase, hardwired.
 - .4 Electrical Output Power: 19.2 kW.
- .3 Electrical Protection:
 - .1 Over current, under voltage, over voltage and residual current.
 - .2 Surge protection, short circuit, over temperature, ground fault.
- .4 Miscellaneous:
 - .1 Lamacoid: Custom inscribed identification instruction signage with nomenclature as confirmed with Owner and reviewed with Consultant.
 - .2 Mounting hardware and accessories suiting installation requirements of units. Refer to drawings.

3. Execution

3.01 INSTALLATION OF ELECTRIC VEHICLE CHARGING STATIONS

- .1 Perform installation work in accordance with manufacturer instructions. Obtain installation drawings and instructions from system manufacturer.

- .2 Refer to drawing details for system infrastructure layout.
- .3 Prior to roughing-in, review installation locations and mounting requirements with Consultant.
- .4 Bollard-mount Units:
 - .1 Refer to drawings for designated bollard units.
 - .2 Coordinate provision of bollards and preparation of grade surface for bollards with general trades.
 - .3 Coordinate provision of excavation, backfilling and concrete work.
 - .4 For surface concrete slab mounted, bolt bollard bases to concrete slab with mounting brackets and hardware suiting application.
 - .5 Secure stations to bollards.
- .5 Provide power and communications conductors in conduit and make connections. Review communications interconnections with Consultant. Where EV system units include ground fault circuit interrupters or residual current devices, connect charger stations to dedicated non-GFCI type circuit breakers in accordance with EV charger manufacturer directions.
- .6 Units without ground fault type protection: Connect units from circuits with ground fault protection.
- .7 Ground and bond equipment. Unless otherwise noted, interconnect grounding with main building grounding.
- .8 Units with Monitoring Software:
 - .1 Programme system for monitoring and billing software applications as required by end users.
 - .2 Confirm requirements with end users prior to start of Work.
- .9 Apply end user graphics or decals to stations as required by end users.
- .10 Access Cards:
 - .1 Review card reader interconnections with Consultant. Provide required communications interconnections. Coordinate with work of Division 27 telecommunications company and as confirmed with end users.
 - .2 System Manufacturer Cards: Prior to substantial performance, turn over cards to Consultant.
 - .3 Confirm type and quantity of cards with end users and review with Consultant.
- .11 After installation is complete:
 - .1 Remove debris from EV charging station and wipe dust and dirt from components.
 - .2 Repaint marred and scratched surfaces with touch-up paint matching original finish.

3.02 IDENTIFICATION

- .1 Provide product identification.
- .2 Provide signage with instructions and secure in locations.
- .3 Review nomenclature with Consultant prior to start of Work.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing and Verification:
 - .1 Inspect, start-up, test and verify products.
 - .2 Check and inspect component connections and overall installation.
 - .3 Check tightness of accessible mechanical and electrical connections verifying torque.
 - .4 Check installation for proper grounding, fastening and alignment.
 - .5 Check software communications between equipment and integrated systems, as applicable for intended applications.
- .2 Prepare testing and verification reports signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards (ANSI):
 - .1 ANSI Z535.1-[2022], American National Standard for Safety Colors.
- .2 CSA Group (CSA):
 - .1 CSA C22.2 No. 178.1-[22], Transfer Switch Equipment, (Tri-national standard, with NMX-J-672 ANCE and UL 1008).
 - .2 CAN/CSA-C22.2 No. 60950-1-[07 (R2021)], Information Technology Equipment - Safety - Part 1: General Requirements (Bi-National standard, with UL 60950-1).
 - .3 CSA C282-[19], Emergency Electrical Power Supply for Buildings.
 - .4 CSA C61869-1-[14(R2019)], Instrument transformers - Part 1: General requirements (Adopted IEC 61869-1:2007, edition 1.0:2007, with Canadian deviations).
 - .5 CSA C61869-2-[14(R2019)], Instrument transformers - Part 2: Additional requirements for current transformers (Adopted IEC 61869-2:2012, edition 1.0:2012, with Canadian deviations).
- .3 International Electrotechnical Commission (IEC):
 - .1 IEC 61000-4-2-[2008], Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test.
 - .2 IEC 61000-4-3-[2022], Electromagnetic compatibility (EMC) - Part 4-3 : Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.
 - .3 IEC 61000-4-4-[2012 RLV], Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test.
 - .4 IEC 61000-4-5-[2014+AMD1:2017 CSV], Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
 - .5 IEC 61000-4-6-[2013], Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields.
 - .6 IEC 61000-4-11-[2020 RLV], Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase.
- .4 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA ICS 2-[2000(R2020)], Controllers, Contactors and Overload Relays Rated 600 V.
 - .2 NEMA ICS 4-[2015], Application Guideline for Terminal Blocks.
- .5 Underwriters Laboratories (UL):
 - .1 ANSI/UL 1008-[2018], Transfer Switch Equipment.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Indicate on drawings:
 - .1 Make, model, type and ratings.
 - .2 Load classification including voltage, ampacity, frequency, poles and withstand current rating.
 - .3 Single line diagram showing controls and relays.
 - .4 Description of automatic transfer 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.
 - .5 Illustrated parts lists with parts catalogue numbers.
- .3 Submit certified copy of factory test results.
- .4 Submit compliance certificates, and testing and verification reports.

2. Products

2.01 GENERAL DESCRIPTION

- .1 Automatic load transfer equipment to:
 - .1 Monitor voltage on phases of normal power supply.
 - .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below pre-set 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, verified 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 Instrument Transformers: In accordance with CSA C61869-1 and CSA C61869-2.
- .3 Contactors: In accordance with NEMA ICS 2.
- .4 Factory Testing:
 - .1 Transfer switches include factory testing verifying proper operation.

- .2 Automatic transfer switches include factory testing for proper operation of individual components and correct overall sequence of operation and to verifying that operating transfer time, voltage, frequency and time delay settings are in compliance with specification requirements.

2.02 AUTOMATIC TRANSFER SWITCHES (ATS) – CONTACTOR TYPE

.1 General:

- .1 CSA certified, automatic transfer switch (ATS), double-throw, electrically operated, mechanically held and fully protected.
- .2 Ratings: As noted.
- .3 In accordance with CSA requirements including standard CSA C22.2 No. 178.1. and CSA C282.
- .4 With withstand current ratings meeting available short circuit currents at location of each transfer switch as determined by electrical distribution system short circuit calculations and coordination study, as specified in Section 26 05 73 – Power System Studies and as reviewed with Consultant.
- .5 Withstand current rating at least equal to larger of normal or emergency side upstream overcurrent protective device rating.
- .6 Suitable for use with emergency sources such as engine or turbine-driven generator source or another utility source.

.2 Components:

- .1 Components intended for continuous duty or repetitive load transfer switching.
- .2 Includes voltage sensing relays, manual transfer facility incorporating spring handles, arc chutes, magnetic blow-out coils, components necessary providing proper performance and operation, and installation and components.
- .3 Components and accessories typically removable from front for ease of service. ATS connections typically made from front.
- .4 Includes pilot lights, selector switches and other controls typically mounted on front door of enclosure.
- .5 Bypass Isolation Switches:
 - .1 Two-way bypass-isolation switch provides manual bypass of load to either source and permits isolation of ATS from source and load power conductors.
 - .2 Manually permits electrical bypass and isolation of ATS that could not otherwise be tested and maintained without interrupting load.
 - .3 Bypass of load to either normal or emergency power source with complete isolation of ATS possible regardless of status of ATS.
 - .4 Bypass isolation permits proper operation by one person through movement of maximum of two handles at common dead front panel.
 - .5 Consists of two elements, automatic transfer switch and bypass-isolation switch, completely factory interconnected and tested.
 - .6 Power interconnections of silver-plated copper bus bars.
- .6 Power Transfer Module and Control Module:
 - .1 Interconnected providing complete automatic operation.
 - .2 ATS mechanically held and electrically operated by single solenoid mechanism energized from source to which load is transferred.
 - .3 ATS rated for continuous duty and be inherently double throw.

- .4 ATS mechanically interlocked for only one of two possible positions:
Normal or emergency.
- .7 Control Panel:
 - .1 Digital microprocessor-controller with LCD display with protective cover.
 - .2 Controller in accordance with:
 - .1 IEC 61000-4-2.
 - .2 IEC 61000-4-4.
 - .3 IEC 61000-4-5.
 - .4 IEC 61000-4-6.
 - .5 IEC 61000-4-11.
 - .3 LCD display includes "System Status" screen readily accessible from any point in menu, and displays clear description of active operating sequence and switch position.
 - .4 Diagnostic screen for purpose of detecting system errors and provides information on status input signals to controller which may be preventing load transfer commands from being completed.
 - .5 Log data and maintain minimum last 99 events, even in event of total power loss. Events time and date stamped and maintained in non-volatile memory.
 - .6 Mounted separately from transfer switch for ease of maintenance.
 - .7 Interconnecting wiring harness includes keyed disconnect plug to disconnect control panel from transfer switch for routine maintenance.
 - .8 Sensing and control logic provided on printed circuit boards.
 - .9 Interfacing relays of industrial grade plug-in type with dust covers.
 - .10 Communications Modules:
 - .1 Provides status, analog parameters, event logs, equipment settings and configurations over embedded webpage and open protocol.
 - .2 Email notifications and SNMP traps of selectable events and alarms may be sent to mobile device or PC.
 - .3 Modbus TCP/IP, SNMP, HTTP, SMTP open protocols simultaneously supported.
 - .4 Web app interface requiring user credentials to monitor and control ATS supporting smart phones, tablets and PC browsers.
 - .5 Secure access provided by requiring credentials.
- .8 Main Contacts:
 - .1 Open Transition: Transfers load as conventional break-before-make switch, in 70 milliseconds or less.
 - .2 Protected by separate arcing contacts with arc barriers between poles.
 - .3 Inspection of contacts (movable and stationary) and coils are possible from front of switch without disassembly of operating linkages and without disconnection of power conductors.
 - .4 Manual operating handle provided for maintenance purposes. Handle permits operator to stop contacts at points throughout entire travel to properly inspect and service contacts.
- .9 Neutral Transfer Contacts:

- .1 Where neutral conductors are switched as noted, include fully rated overlapping neutral transfer contacts.
- .2 Neutrals of normal and emergency power sources connected together only during transfer and retransfer operation and remain connected together until power source contacts close on source to which transfer is being made.
- .3 Overlapping neutral contacts do not overlap for period greater than 100 milliseconds.
- .10 Sensing and Control Logic Panel:
 - .1 Solid state sensing initiates emergency mode of operation upon reduction of normal source to below 90% of nominal voltage and retransfer to normal when normal source restores to 90% and above of nominal.
 - .2 Pick-up voltage adjustable from 85% to 100% of nominal and dropout voltage adjustable from 75% to 98% of pick-up value.
- .3 Other System Features:
 - .1 Time delay to override momentary normal source outages to delay transfer switch and engine starting signals. Adjustable from 0.5 to 6 seconds and initially set at one second.
 - .2 Time delay for controlled time of load transfer to emergency. Adjustable from 0 to 8 minutes and initially set at 0 minutes.
 - .3 Time delay for unloaded running time delay for emergency generator cool-down. Adjustable from 0 to 30 minutes and initially set at five minutes.
 - .4 Time delay on retransfer to normal source set to automatically by-pass when emergency source fails and normal source is available. Adjustable from 0 to 30 minutes and initially set at five minutes.
 - .5 Engine start contact which closes on normal power failure initiating engine start-up. Where multiple start-up signals are required, include suitable relay module.
 - .6 Preferred source selection.
 - .7 Selector switches to perform "TEST", "AUTO", "RESET", "MANUAL (or OFF)" and "ENGINE START" functions.
 - .8 Pilot lights (P/L) indicating switch positions.
 - .9 Suitable connections for conductors. Top entry wiring unless otherwise noted.
 - .10 Frequency relay to prevent emergency load transfer until frequency of emergency source has reached its set value.
 - .11 In-phase monitoring of motor load with generator for transfer from normal to emergency and vice versa, by means of monitor sampling relative phase angle and frequency different and signals transfer switch to close when two voltages are at required phase angle.
 - .12 Auxiliary Contacts:
 - .1 Minimum two normally open and two normally closed auxiliary contacts.
 - .2 Signally to other systems and equipment that ATS has transferred due to loss of normal power and initiating emergency sequence of operations.
 - .3 Signally common alarm to BAS.
 - .13 Indicators showing switch position.
 - .14 Momentary contact switch allowing built-in time delay on retransfer to normal be bypassed.

- .15 Pilot light illuminates when load is connected to emergency source.
- .16 Transfer Switches supplying power for elevators: With selective load disconnect and time delay control circuit inhibiting transfer for pre-set amount of time to allow elevator controls to sense contact position of transfer switch and program itself to accommodate up-coming transfer.
- .17 External DC power supply for control panel LCD and door mounted control indicators to remain functional when both power sources are not available.
- .18 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and ATS manufacturer recommendations.
- .4 Manufacturer Services:
 - .1 Manufacturer technician:
 - .1 To inspect installation by installing contractor and provide technical assistance.
 - .2 To perform with installing contractor, onsite testing, start-up, and verification of transfer switches.

2.01 AUTOMATIC TRANSFER SWITCHES (ATS) – CONTACTOR TYPE

- .1 General:
 - .1 CSA certified, in accordance with CSA requirements including standard CSA C22.2 No. 178.1 and CSA C282.
 - .2 Controller in accordance with:
 - .1 IEC 61000-4-2.
 - .2 IEC 61000-4-4.
 - .3 IEC 61000-4-5.
 - .4 IEC 61000-4-6.
 - .5 IEC 61000-4-11.
 - .3 Ratings: As noted.
 - .4 With withstand current ratings meeting available short circuit currents at location of each transfer switch as determined by electrical distribution system short circuit calculations and coordination study, as specified in Section 26 05 73 – Power System Studies and as reviewed with Consultant.
 - .5 Withstand current rating at least equal to larger of normal or emergency side upstream overcurrent protective device rating.
 - .6 Suitable for use with emergency sources such as engine or turbine-driven generator source or another utility source.
- .2 Features:
 - .1 Modular, compact design, factory tested ensuring proper operation of individual components and correct overall sequence of operation and ensuring that operating transfer time, voltage, frequency and time delay settings are in compliance with specification requirements.
 - .2 Single solenoid design, momentary energized, inherently interlocked and prevents contacts from stopping between sources or from being in contact with both sources at same time.
 - .3 Electrically operated and mechanically held.

- .4 Positively locked and unaffected by momentary outages so that contact pressure maintained at constant value and temperature rise at contacts is minimized for maximum reliability and operating life.
- .5 Where rated 800 amperes and above: Includes segmented, blow-on construction for high withstand current capability and protection with separate arcing contacts.
- .6 Silver composition main contacts.
- .7 Control and display panel.
- .8 Where neutral conductors switched: Include fully-rated neutral transfer contacts.
- .9 Where neutral conductors are solidly connected: Include neutral terminal plate with fully-rated AL-CU pressure connectors.
- .10 Wall mounted or self-standing as noted.
- .11 Fully front accessible with inspection of contacts from front of switch and components and accessories removable from front.
- .12 Pilot lights, selector switches and other controls mounted on front door of enclosure and connections typically made from front.
- .3 Control Panel Features:
 - .1 Flush-mounted Digital Microprocessor Controllers:
 - .1 Direct operation of transfer switch, with sensing and logic controlled by built-in microprocessors, with serial and Ethernet communications.
 - .2 With backlit graphical display, keypad and LED indicators for switch position and source acceptability.
 - .3 Includes test and time-delay bypass switches.
 - .4 Controller enclosed protective cover.
 - .5 Mounted separate from transfer switch unit.
 - .6 With instructions and controller settings easily accessible, readable and accomplished without use of codes, calculations, or instruction manuals.
 - .2 Voltage, frequency, control, timing and connectivity functions required for most emergency and standby power applications;.
 - .3 Voltage and Frequency Sensing:
 - .1 Voltage and frequency on both normal and emergency sources continuously monitored, with pickup, dropout, and trip settings capabilities.
 - .2 Voltage of each phase of normal source monitored, with pickup adjustable to 95% of nominal and dropout adjustable from 70% to 90% of pickup setting.
 - .3 Single-phase voltage and frequency sensing of emergency source provided.
 - .4 Voltage sensing: True RMS type and accurate to $\pm 1\%$ of nominal voltage.
 - .5 Frequency sensing: accurate to $\pm 0.1\text{Hz}$
 - .6 Sensing and control logic provided on printed circuit boards.
 - .7 Interfacing relays: Industrial grade plug-in type with dust covers.
 - .4 System Status Screen:
 - .1 Readily accessible from any point in menu by depressing "ESC" key.
 - .2 Displays clear description of active operating sequences and switch position.

- .5 Self-Diagnostics Screen:
 - .1 Detecting system errors.
 - .2 Provides information on status input signals to controller which may be preventing load transfer commands from being completed.
- .6 Data Logging:
 - .1 Log data and maintain last minimum 99 events, even in event of total power loss.
 - .2 Events time and date stamped and maintained in non-volatile memory.
- .7 Time Delays:
 - .1 Time delay settings: Accurate to $\pm 0.5\%$ of full-scale value of time delay.
 - .2 Time delay overrides momentary normal source outages and delay transfer and engine starting signals, adjustable 0 to 6 seconds. Possible to bypass time delay from controller user interface.
 - .3 Time delay on transfer to emergency, adjustable from 0 to 60 minutes 59 seconds for controlled timing of transfer of loads to emergency. Possible to bypass time delay from controller user interface.
 - .4 Generator stabilization time delay after transfer to emergency adjustable 0 or 4 seconds.
 - .5 Time delay on retransfer to normal, adjustable 0 to 9 hours 59 minutes 59 seconds. Time delay automatically bypassed if emergency source fails, and normal source is acceptable.
 - .6 Cool-down time delay on shutdown of engine generator, adjustable 0 to 60 minutes 59 seconds.
 - .7 Delayed transition operation time delay for load disconnect position, adjustable 0 to 5 minutes 59 seconds.
 - .8 Adjustable time delays field adjustable without use of special tools.
 - .9 Time delay activated output signal drives external relays for selective load disconnect control. Controller activates adjustable 0 to 5 minutes 59 seconds time delay in any of following modes:
 - .1 Prior to transfer only.
 - .2 Prior to and after transfer.
 - .3 Normal to emergency only.
 - .4 Emergency to normal only.
 - .5 Normal to emergency and emergency to normal.
 - .6 All transfer conditions or only when both sources are available.
 - .10 In event that alternate source is not accepted within configured failure to accept time delay, common alert indication becomes active.
- .4 Additional ATS Components:
 - .1 Single-sided isolation-bypass switch: Provides manual bypass of load to emergency source and permit isolation of transfer switch from all source and load power conductors; all main contacts manually driven.
 - .2 User interface with test/reset modes. Test mode simulates normal source failure. Reset mode bypasses time delays on either transfer to emergency or retransfer to normal.

- .3 Set of contacts rated 5 amps, 30 VDC, for low-voltage engine start signal. Start signal prevents dry cranking of engine by requiring generator set to reach proper output, and run for duration of cool down setting, regardless of whether normal source restores before load is transferred.
- .4 Push-button type test switches:
 - .1 One simulates normal source failure.
 - .2 One bypasses time delay on transfer to emergency, engine exerciser period on retransfer to normal time delay whichever delay is active at time push-button is activated.
- .5 Terminals for remote contact which opens to signal ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency, and retransfer to normal.
- .6 Terminals for indicating actual availability of normal and emergency sources, as determined by voltage sensing pickup and dropout settings for each source.
- .7 Auxiliary contacts:
 - .1 Rated 10 amps, 250 VAC.
 - .2 One contact, closed when ATS is connected to normal source.
 - .3 One contact, closed, when ATS is connected to emergency source.
 - .4 Indicate position of main contacts:
 - .1 2 for normal position and 2 for emergency position (one set is standard).
 - .5 Contacts for operating remote connected systems such as alarms.
- .8 Single alarm indication lights up alert indicator and de-energizes configured common alarm output relay for external monitoring.
- .9 LED indicating lights:
 - .1 One indicates when ATS is connected to normal source (green).
 - .2 One indicates when ATS is connected to emergency source (red).
 - .3 For both normal and emergency source availability.
 - .4 Indicates switch not in automatic mode (manual) and blinking (amber) indicating transfer inhibit.
 - .5 Indicates any alarm condition or active time delay (red).
- .10 Ability to select "commit/no commit to transfer" determining whether load transferred to emergency generator if normal source restores before generator is ready to accept load.
- .11 Engine Generator Exercising timer including selector switch for selecting exercise with or without load transfer.
- .12 In-phase Monitors:
 - .1 Inherently built into controls to control transfer so that motor load inrush currents do not exceed normal starting current.
 - .2 Not require external control of power sources.
 - .3 Specifically designed for and be product of ATS manufacturer.
- .13 Selective Load Disconnect:
 - .1 Double throw contact operates after a time delay, adjustable to 20 seconds prior to transfer and reset 0 to 20 seconds after transfer.
 - .2 Contact used to selectively disconnect specific loads when transfer switch is transferred.

- .3 Output contacts rated 6 amps at 28 VDC or 120 VAC.
- .14 ATS supplying power for elevators: Equipped with selective load disconnect and time delay control circuit inhibiting transfer for pre-set amount of time allowing elevator controls to sense contact position of transfer switch to program itself to accommodate up-coming transfer.
- .15 Strip heater with thermostat, wired to load terminals and suitable for supply voltage as noted.
- .16 Communications Interfaces:
 - .1 Module allows several different serial devices that communicate at different baud rates and with different protocols to common Ethernet media.
 - .2 Standard Ethernet TCP/IP network with standard 10 base-T (RJ-45) connector.
 - .3 Designed to communicate with up to 8 clients such as Web applications (web pages) simultaneously over Ethernet connection.
- .17 Engraved Lamacoid Nameplates: Identifying switch and components.
- .18 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and ATS manufacturer recommendations.
- .5 Manufacturer Services:
 - .1 Manufacturer technician:
 - .1 To inspect installation by installing contractor and provide technical assistance.
 - .2 To perform with installing contractor, onsite testing, start-up, and verification of transfer switches.

2.02 AUTOMATIC TRANSFER SWITCHES (ATS) - BREAKER TYPE

- .1 General:
 - .1 CSA certified, ULC listed and labeled, automatic transfer switch (ATS), double-throw, electrically operated, mechanically held and fully protected.
 - .2 Ratings: As noted.
 - .3 In accordance with CSA requirements including standard CSA C22.2 No. 178.1 and CSA C282.
 - .4 With withstand current ratings meeting available short circuit currents at location of each transfer switch as determined by electrical distribution system short circuit calculations and coordination study, as specified in Section 26 05 73 – Power System Studies and as reviewed with Consultant.
 - .5 Withstand current rating at least equal to larger of normal or emergency side upstream overcurrent protective device rating.
 - .6 Suitable for use with emergency sources such as engine or another utility source and designed and intended for switching load connection between two power sources.
 - .7 Open Transition (Break-Before-Make):

- .1 Provides time delay in load disconnect (neutral) position adjustable from 0 to 600 seconds that permits delayed transition, and provides in-phase monitor that permits in-phase transition between two live sources that have phase angle difference of +/- 8 degrees or less (no generator sources) and +/- 5 degrees or less (1-2 generator sources).
 - .2 In event that sources do not synchronize to complete in-phase transition within time delay period adjustable from 1 to 60 minutes, transfer switch capable of defaulting to delayed transition adjustable from 0 to 600 seconds or load voltage decay transition adjustable from 2 to 30% of nominal voltage.
- .2 Transfer Switches:
- .1 ATS is double throw, operated by single solenoid mechanism momentarily energized.
 - .2 ATS includes power circuit breakers in draw-out or fixed mount configuration as noted.
 - .3 Switch is inherently interlocked mechanically and electrically.
 - .4 Failure of any coil or part does not permit a neutral position.
 - .5 Switch is positively locked mechanically on either source without hooks, latches, springs, etc.
 - .6 Main contacts are silver surfaced, electrically operated and mechanically held in position and protected by arcing contacts and arc barriers.
 - .7 Removable arc chutes, housed within arc chamber constructed of high-dielectric high-strength material, are mounted over each set of main contacts. Arc chutes constructed of metal plates and baffle cover designed to extinguish electrical arc and protect main contacts.
 - .8 ATS provided with full protection to initiate transfer of load to generator power supply when voltage of normal power supply drops to 90% on any phase and re-transfers it to normal power when supply is restored to 90% in all phases as described above; voltage sensing relays have close differential of 2%, with independent adjustable pick up and drop out features.
 - .9 Normal power supply from main switchboard is construed as preferred power source.
 - .10 Switch includes magnetic blow-out coil.
 - .11 Switch capable to communicate via Ethernet or other protocol compatible with BAS.
- .3 Breakers:
- .1 Power circuit breakers with typical requirements as specified in Section 26 28 16 - Low Voltage Breakers.
- .4 Bypass Switch:
- .1 Two-way bypass isolation switch to provide manual bypass of load to either source and permit isolation of ATS (for maintenance) from all source and load power conductors.
 - .2 Main contacts manually driven.
 - .3 Power interconnections are silver-plated copper bus bar; only field installed power connections to be at service and load terminals of bypass-isolation switch.
 - .4 Control inter-wiring provided with disconnect plug type terminations.

- .5 Separate bypass and isolation handles utilized to provide clear distinction between functions; handles permanently affixed and operable without enclosure door.
 - .6 Bypass to load-carrying source accomplished with no interruption of power to load (make before break contacts).
 - .7 Bypass handle three operating modes, as follow:
 - .1 Bypass to normal.
 - .2 Automatic.
 - .3 Bypass to emergency.
 - .8 Operating speed of bypass contacts same as associated transfer switch and be independent of speed at which manual handle is operated.
 - .9 In 'automatic' mode, bypass contacts out of power circuit so that they will not be subjected to fault currents to which system may be subjected.
 - .10 Isolation handle three operating modes, as follow:
 - .1 Closed.
 - .2 Open.
 - .3 Test.
 - .11 Test mode permits testing of entire emergency power system, including ATS with no interruption of power to load.
 - .12 Open mode completely isolates ATS from all sources and load power conductors; when in 'open' mode it is possible to completely withdraw ATS for inspection or maintenance to conform to code requirements without removal of power conductors or use of any tools.
 - .13 When isolation switch is in 'test' or 'open' mode, bypass switch functions as manual transfer switch.
- .5 Instrumentation:
- .1 Voltage monitoring of normal and emergency power supply with adjustable set point.
 - .2 Adjustable time delayed switching from normal to emergency source and voltage check between normal and emergency sources before change over from emergency to normal source.
 - .3 Single-line graphic on door with signal lamps to indicate position of transfer switch.
 - .4 Switch for control of transfer from emergency source to normal source.
 - .5 Volt-free, 2 N.O. and 2 N.C. auxiliary contacts for remote indication of position of transfer switch.
- .6 Control and Monitoring:
- .1 Transfer switch control power obtained from source to which being transferred. Controls do not require connection to external power sources.
 - .2 Control circuit isolation plug, which isolates control circuitry inside ATS to facilitate maintenance procedures. When isolated, there is no voltage present on control circuitry.
 - .3 Microprocessor based ATS controller contains voltage and frequency sensing, timing functions and metering and is in accordance with:
 - .1 IEC 61000-4-2.
 - .2 IEC 61000-4-3.

- .3 IEC 61000-4-4.
- .4 IEC 61000-4-5.
- .5 IEC 61000-4-6.
- .6 IEC 61000-4-11.
- .4 Door mounted operator interface liquid crystal display (LCD) for ATS controller includes keypad for following pushbutton controls:
 - .1 ENGINE TEST, for use with generator source.
 - .2 LEFT, RIGHT, UP, DOWN, and ENTER, for ease of navigation and programming.
 - .3 HELP/LAMP TEST, for operator assistance and diagnostics.
 - .4 BYPASS TIMER, to bypass time delay countdown.
- .5 3-level security password system for ATS controller software program to access programming functions. Specific password levels provided for "read only", "read/write" and "master". Programming set points for voltage, frequency and time delays are software programmable from front panel mounted keypad and parameters displayed in alphanumeric format.
- .6 Main overview screen displays:
 - .1 Voltage and frequency: Source 1, source 2, and load.
 - .2 Status condition based on setpoints: Source 1 and source 2.
 - .3 Time and date
 - .4 Electric current: Load
- .7 LCD displays following:
 - .1 System time.
 - .2 Transfer switch position.
 - .3 Utility supply metering: 3-phase voltage and frequency.
 - .4 Generator supply metering: 3-phase voltage and frequency.
 - .5 Timer countdown display.
 - .6 Test mode operation indication.
- .8 LED indicators and mimic power bus included for display of:
 - .1 Availability status of Source 1.
 - .2 Availability status of Source 2.
 - .3 Connection status of Load to Source 1.
 - .4 Connection status of Load to Source 2.
 - .5 Preferred status of Source 1.
 - .6 Preferred status of Source 2.
- .9 Digital metering for ATS controller:
 - .1 Accuracy of +1% for all voltage and frequency readings.
 - .2 Frequency displayed to at least one decimal.
 - .3 Three-phase line-to-line voltages displayed for both generator and utility supplies.
- .10 Three-phase under voltage sensing for both utility and generator supplies; under voltage sensing function programmable as follows:
 - .1 Under voltage pick-up: 70 to 100% of nominal, factory set at 90%.
 - .2 Under voltage dropout: 70 to 100% of nominal, factory set at 80%.
 - .3 Under voltage delay: 0 to 10 seconds, factory set at 1 second.

- .11 Frequency sensing for generator supply permits load transfer to generator supply if within nominal limits; generator frequency sensing function programmable, as follows:
 - .1 Under frequency: 50 to 60.0 Hz, factory set at 57.0 Hz.
 - .2 Under frequency time delay: 0 to 10 seconds, factory set at 5 seconds.
 - .3 Over frequency: 60.0 to 70.0 Hz, factory set at 63.0 Hz.
 - .4 Over frequency time delay: 0 to 10 seconds, factory set at 5 seconds.
- .12 Engine start contact:
 - .1 Closes to initiate starting of engine.
 - .2 Engine start contact rated: 10A, 230VAC, 56VDC resistive (maximum).
- .13 Time delay on engine start to delay engine start signal after failure of utility source; time delay programmable, 0 - 60 seconds, factory set at 2 seconds.
- .14 Time delay for engine warm-up:
 - .1 Permits transfer to generator supply after generator voltage and frequency exceed acceptable limits.
 - .2 Time delay programmable 0 to 1800 seconds, factory set at 2 seconds.
- .15 Time delay for retransfer to utility:
 - .1 Permits transfer to utility supply only after stable voltage conditions exist for specified time period.
 - .2 Time delay programmable 0 to 20 minutes, factory set at 2 minutes.
- .16 Time delay for engine cool down:
 - .1 Delays engine stop signal after load has retransferred to utility source until time delay period expires.
 - .2 Time delay programmable 0 to 30 minutes, factory set at 2 minutes.
- .17 Provision for operator-initiated system test modes: Test modes programmable for "off load" testing (load does not transfer to generator) or "on load" testing (load does transfer to generator).
- .18 Automatic exercise time function for generator testing:
 - .1 24 hour, 7-day, single occurrence programmable time clock.
 - .2 Time clock programmable for test start and stop times (i.e. "day of week", "hour of day", and "minute of day", and type of test (i.e. "on load" or "off load").
- .19 Control logic for immediate transfer to utility supply (if within acceptable limits) should generator set fail during any activated test mode.
- .20 Diagnostic indicating light's on ATS controller allowing simple visual indication of ATS operating conditions. Individual lights provided for following functions:
 - .1 Watchdog (CPU running).
 - .2 Transfer to Utility supply signal initiated.
 - .3 Transfer to Generator supply signal initiated.
 - .4 Engine start signal initiated.
- .21 Transfer switch controller with lamp test function to test indicating lights and LCD display.
- .22 Four-function test switch, on door of ATS, providing following control functions:
 - .1 AUTO: Genset automatically operates during utility power failure condition in accordance with sequence of operation.

- .2 ENGINE START: Genset immediately starts and operates unloaded. Load automatically transfers to genset should utility power failure condition occur.
- .3 TEST: Genset immediately starts and transfers load upon expiration of warm-up delay. Transfer switch automatically retransfers load back to utility supply should genset set fail on load.
- .4 OFF: Genset disabled from automatic starting due to utility power fail condition.
- .23 Utility Supply Auxiliary Contacts (AUX-U):
 - .1 Auxiliary contacts, which operate when utility source is on load.
 - .2 Two spare auxiliary contacts supplied with rating of 10 A, 230 VAC resistive Form-C.
- .24 Generator Supply Auxiliary Contacts (AUX-G):
 - .1 Auxiliary contacts, which operate when generator is on load.
 - .2 Two spare auxiliary contacts supplied with rating of 10 A, 230 VAC resistive Form-C.
- .25 Load Disconnected Contact (LDC):
 - .1 Control logic to signal external load (e.g. elevator) of impending transfer to and from generator supply.
 - .2 Output contact rated 10A, 230VAC resistive, closes prior to transfer and remains closed until transfer is completed and post-transfer delay time expires.
 - .3 Pre-transfer delay function provided, programmable 0 to 30 seconds, factory set at 10 seconds.
 - .4 Post-transfer delay function provided, programmable 0 to 30 seconds, factory set at 10 seconds.
- .26 Over-Voltage Sensing (OVS):
 - .1 Three-phase over-voltage sensing for both utility and generator supplies.
 - .2 Voltage sensing function programmable as follows:
 - .1 Over-voltage pickup: 100 to 130% of nominal, factory set at 110%.
 - .2 Over-voltage dropout: 100 to 130% of nominal, factory set at 108%
 - .3 Over-voltage time delay: 0 to 10 seconds, factory set at 5 seconds.
- .27 Utility Frequency Sensing (UOF):
 - .1 Frequency sensing for utility supply to permit load transfer to utility supply if within acceptable limits.
 - .2 Utility frequency sensing programmable as follows:
 - .1 Under frequency: 50.0 to 60.0 Hz, factory set at 57.0 Hz.
 - .2 Under frequency time delay: 0 to 10 seconds, factory set at 5 seconds.
 - .3 Over frequency: 60.0 to 70.0 HZ, factory set at 63.0 Hz.
 - .4 Over frequency time delay: 0 to 10 seconds, factory set at 5 seconds.
- .28 Utility Power Available Contacts (UPA):
 - .1 Auxiliary contacts which operate when utility power is available.

- .2 Two spare auxiliary contacts supplied with rating of 10 A, 230 VAC resistive Form-C.
- .29 Generator Power Available Contacts (GPA):
 - .1 Auxiliary contacts which operate when generator power is available.
 - .2 Two spare auxiliary contacts supplied with rating of 10A, 230 VAC resistive Form-C.
- .30 Fail to Transfer Contacts (FTT):
 - .1 Auxiliary contacts, which activate when transfer switch mechanism fails to operate within specified time delay.
 - .2 Time delay programmable 0 to 60 seconds, factory set at 15 seconds.
 - .3 Two spare auxiliary contacts supplied with rating of 10 A, 230 VAC resistive Form-C.
- .31 Phase Balance Relay (PBR):
 - .1 Protects connected motors in system against unbalanced supply voltages caused by "single phasing condition" (e.g. one fuse blown on a 3-phase supply).
 - .2 When unbalanced condition occurs on utility supply, system initiates transfer to generator supply.
- .7 Sequence of Operation of ATS:
 - .1 When normal supply at ATS on one or more phases has been interrupted or system voltage is less than 90% of rated system voltage for period of 1 to 5 seconds, contact to close to start emergency generator.
 - .2 When emergency supply reaches 90% of rated system voltage for adjustable time period of 1 to 5 seconds, load transfers to emergency supply.
 - .3 On restoration of normal supply and after voltage and frequency have been maintained at nominal levels on all phases for adjustable period of 0.5 to 30 minutes, load transfers back to normal supply, as soon as phase angle between main and emergency supply is less than 10 degrees; however, this time delay is bypassed if emergency supply is lost.
 - .4 Emergency generator starter contact is opened after load has been transferred back to normal supply after adjustable time period of 0 to 30 minutes.
- .8 Cam-Lok Style Power Panels:
 - .1 Provides docking station for temporary generators or load banks.
 - .2 Cam-Lok style receptacles allow quick connection of power cables.
 - .3 Isolated compartment, with independent locking door, houses Cam-Lok power panel eliminating exposure to energized transfer switch.
 - .4 Hinged flap at enclosure bottom secures in closed position when power cables not installed.
 - .5 Field conversion ready design allows connection of future permanent generator.
 - .6 Cam-Lok style connections colour-coded with engraved identification nameplates secured via metal hardware for ease of identification.
- .9 Remote Annunciators:
 - .1 For monitoring and control of ATS remotely.
- .10 Miscellaneous:

- .1 Components and accessories typically accessible and removable from front for ease of service.
- .2 Pilot lights, selector switches and other controls typically mounted on front door of enclosure.
- .3 ATS connections typically made from front.
- .4 Engraved Lamacoid nameplates identifying switch and components.
- .5 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and ATS manufacturer recommendations.
- .6 Manufacturer Services:
 - .1 Manufacturer technician:
 - .1 To inspect installation by installing contractor and provide technical assistance.
 - .2 To perform with installing contractor, onsite testing, start-up, and verification of transfer switches.

2.03 ENCLOSURES

- .1 Dead front access, floor-mounted or wall-mounted as noted, suiting intended applications, enamelled painted steel.
- .2 Climate-controlled Areas: Minimum NEMA 1 unless otherwise noted, cubicle with additional sprinkler protection provisions including drip shield, ventilation louvers designed to protect live components from water spray from activated sprinklers and gasketed doors and openings.
- .3 Non-climate-controlled Areas: Minimum NEMA 3R unless otherwise noted, cubicle, with weather-resistant and corrosion-resistant finishes. Exposed hardware is weather-resistant and corrosion-resistant.
- .4 Units finished in manufacturer standard ANSI grey or green enamel, unless otherwise noted. Prior to ordering, review finishes with Consultant.

2.04 CUSTOM IDENTIFICATION PAINTING

- .1 Factory paint transfer switches connected to emergency or essential power systems with enamel paint in dedicated colour finish (typically ANSI Z535.1 standard orange or red), as reviewed with Consultant.

2.05 MANUFACTURER FACTORY TESTING

- .1 Provide automatic transfer switch documented factory testing reports that include following:
 - .1 Check of insulation verifying integrity of insulation and continuity of entire system.
 - .2 Visual inspection verifying switch matches specification requirements and that fit and finish meet quality standards.
 - .3 Perform testing of complete equipment, including transfer mechanism, controls, relays and accessories.
 - .4 Operate equipment both mechanically and electrically verifying proper performance.
 - .5 Mechanical testing verifying switch power sections are free of mechanical hindrances.

- .6 Electrical testing verifying electrical operation of switch and setting of time delays and voltage sensing of logic.
- .7 Identification indicating order number, catalog number and date of testing.
- .2 Submit reports as part of Shop Drawing submissions.

2.06 MANUFACTURER AUTHORIZED TECHNICIAN SERVICES

- .1 Provide technical assistance during installation.
- .2 Perform after installation onsite inspection, start-up, testing and verification of transfer switches.
- .3 Prepare and sign testing and verification reports in coordination with third party testing company under work of Section 26 05 70 – Electrical Testing.

2.07 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Manual Transfer Switches:
 - .1 Eaton.
 - .2 ASCO.
 - .3 Schneider.
 - .4 Siemens.
- .2 Automatic Transfer Switches – Contactor Type:
 - .1 ASCO.
 - .2 Cummins.
 - .3 Caterpillar.
 - .4 Eaton.
 - .5 Thomson (Regal Rexnord).
- .3 Automatic Transfer Switches – Breaker Type:
 - .1 Eaton.
 - .2 Thomson (Regal Rexnord).

3. Execution

3.01 INSTALLATION OF MANUAL TRANSFER SWITCHES

- .1 Install in locations and connect complete with wiring in conduit.
- .2 Install in accordance with manufacturer instructions.
- .3 Ground and bond equipment.
- .4 Coordinate transfer switch testing with connected equipment testing and verify operations are correct. Adjust suiting intended applications.

3.02 INSTALLATION OF AUTOMATIC TRANSFER SWITCHES

- .1 Provide transfer switches suiting intended applications. Refer to drawings for transfer switch ratings and mounting locations. Advise transfer switch manufacturer of coordination study available fault current results, ensuring transfer switches are provided of withstand current rating meeting available fault current at location of each transfer switch.

- .2 Locate, install and connect transfer equipment.
- .3 Obtain training from manufacturer representative on special installation procedures.
- .4 Install in accordance with manufacturer instructions, suiting intended applications. Mount stand-alone units to concrete bases. Install with clearance for access for operation and maintenance. Connect complete.
- .5 Provide seismic restraints as specified.
- .6 Check relays and solid-state monitors and adjust for correct operation.
- .7 Where required in emergency power distribution system connected to gensets, provide wiring in conduit from genset control panel to appropriate transfer switches contacts to initialize engine start-up upon loss of normal power and provide signals to transfer switches to initiate appropriate operations. Where load banks are connected to genset control system during testing, include for interconnection wiring in conduit for loss of normal power signal to load bank controllers, initiating dropping load bank to pick-up essential building loads.
- .8 Provide MI fire-rated conductors:
 - .1 To transfer switches used for life safety applications in accordance with building code.
 - .2 For wiring interconnections as noted.
 - .3 Where required by building code.
- .9 Provide alarm and communications circuits. Integrate equipment to BAS. Extend wiring in conduit to interconnection terminal cabinet. Provide wiring in conduit from cabinet to respective BAS panel serving area. Make connections. Coordinate requirements with respective equipment vendors.
- .10 Install and connect remote alarms.
- .11 Ground and bond equipment.
- .12 Provide seismic restraints as noted.

3.03 ADDITIONAL REQUIREMENTS FOR INSTALLATION OF TRANSFER SWITCHES FOR ELEVATORS

- .1 Coordinate work with requirements of Division 14 and sequence of operation of elevators.
- .2 Provide transfer switches connected to elevators, with relays and interlocking as required to control transfer of elevators.
- .3 Elevator transfer switch sensing panel initiates emergency mode of operation if a drop to 90% or less on any phase of normal service exceeds three seconds in duration. In emergency mode, transfer switch transfers to emergency bus and elevator controls to take over and bring elevators, one at a time, down to designated level and maintains one elevator (firemen elevator) operating continually.
- .4 Restoration to normal operation commences when phases of normal service have returned to 95% of nominal for adjustable period of up to two minutes maximum. Transfer switch re-transfers to its normal position, allowing elevators to resume normal service, signal for emergency mode to elevator control cancelled, and system is then ready for next normal service failure without any manual resetting.
- .5 System designated transfer switch includes test position allowing elevators to remain in use during testing of emergency transfer system scheme.

3.04 IDENTIFICATION

- .1 Provide product identification.
- .2 Nameplates:
 - .1 Main equipment: Size 5 unless otherwise noted.
 - .2 Selector Switches: Size 5 unless otherwise noted.
 - .3 Meters, Indicating Lights, Minor Controls: Size 3 unless otherwise noted.
 - .4 Nomenclature reviewed with Consultant.

3.05 FIELD QUALITY CONTROL

- .1 When installation is complete, arrange for system manufacturer authorized technician to visit site to inspect installation, perform testing and start-up procedures, and certify system. In presence of Consultant and Commissioning Agent, perform complete operational test of system to verify that system operates satisfactorily under operating conditions specified and reviewed with Consultant.
- .2 Coordinate transfer switch testing with engine-generator set testing and verify that complete emergency power plant operates correctly. Adjust suiting intended applications.
- .3 Inspection, Start-up, Testing and Verification:
 - .1 General:
 - .1 Operate equipment both mechanically and electrically ensuring performance in accordance with design requirements and manufacturer specifications.
 - .2 Check selector switch, in modes of operation: Test, Auto, Manual, Engine Start (as applicable). Record results.
 - .3 Check voltage sensing and time delay relay settings.
 - .4 Check:
 - .5 Automatic starting and transfer of load on failure of normal power.
 - .6 Retransfer of load when normal power supply resumed.
 - .7 Automatic shutdown.
 - .8 In-phase monitor operation, where applicable.
 - .2 Engine-Generator Sets:
 - .1 Coordinate transfer switch testing with engine-generator set testing, verifying that complete emergency power plant operates correctly. Adjust as required.
 - .2 Energize transfer equipment from normal power supply.
 - .3 Set selector switch in "Test" position for standby start, running, transfer, and retransfer. Return selector switch to "Auto" position for standby shutdown.
 - .4 Set selector switch in "Manual" position and check for proper performance.
 - .5 Set selector switch in "Engine Start" position and check for proper performance. Return switch to "Auto" to stop engine.
 - .6 Set selector switch in "Auto" position and open normal power supply disconnect. Standby starts, comes up to rated voltage and frequency, and load transfers to standby. Allow to operate for minimum ten minutes, then close main power supply disconnect. Load transfers back to normal power supply and standby shutdowns.

- .7 Repeat, at one-hour intervals, and as reviewed with Consultant.
- .4 Arrange for manufacturer to provide compliance certificate. Certification to identify equipment involved in testing by serial numbers. Include copies with reports.
- .5 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 269.1-[17(R2022)], Surge Protective Devices - Type 1 - Permanently Connected.
- .2 Institute of Electrical and Electronic Engineers (IEEE):
 - .1 IEEE C62.41.1-[2002(R2008)], IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
 - .2 IEEE C62.45-[2002(R2008)], IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits.
- .3 Underwriters Laboratories (UL):
 - .1 ANSI/UL 1283-[2024], Electromagnetic Interference Filters.
 - .2 ANSI/UL 1449-[2022], Standard for Surge Protective Devices.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports.

2. Products

2.01 SURGE PROTECTIVE DEVICES (SPD) – GENERAL FEATURES

- .1 Ratings and Standards:
 - .1 Ratings: As noted, suiting intended applications.
 - .2 CSA certified, or ULC listed and labeled.
 - .3 In accordance with:
 - .1 CSA C22.2 No. 269.1.
 - .2 IEEE C62.41.1 and IEEE C62.45.
 - .3 ANSI/UL 1283 and ANSI/UL 1449.
 - .4 IEEE Exposure: Category C.
- .2 Mounting:
 - .1 Internally integrated to utility service entrance equipment.
 - .2 Internally integrated to distribution equipment, unless otherwise noted.

- .3 Where external units are provided, install in space adjacent to equipment, maintaining SPD manufacturer limitation on length of connecting conductor.
- .4 Connect SPD units to equipment with breakers in accordance with manufacturer instructions.
- .5 For switchgear and switchboards: Unless otherwise noted, mount in dedicated front facing cell or main breaker compartment or cubicle.
- .3 Indicator LEDs on units identify protection integrity status of metal-oxide varistors. For integral units, indicator visible on front of switchgear/switchboard and panelboards.
- .4 High-performance EMI/RFI noise rejection filter.
- .5 Diagnostic package with status indicators on each phase.
- .6 LCD surge counter display.
- .7 Audible alarm with silence button.
- .8 Form C alarm contacts.
- .9 Internal disconnect.
- .10 Maintenance-free and not require user intervention throughout its life.
- .11 Standard manufacturer minimum 5 years parts and labour warranty.
- .12 Operating Temperatures: Minus 40°C to 60°C.
- .13 Internal Mounted Housings: Manufacturer standard steel housings, suiting requirements of internal to equipment installations.
- .14 External Mounted Enclosures:
 - .1 Power coated or enamel painted steel construction.
 - .2 Climate Controlled Areas: Minimum NEMA 2 or NEMA 12, unless otherwise noted.
 - .3 Non-climate Controlled Areas: Minimum NEMA 3R or NEMA 4, outdoor weatherproof and corrosion-resistant.

2.02 SPD RATINGS AND TYPES

- .1 Type 1 and Type 2 Units: Applications and with ratings as noted.
- .2 Type 1 Units: Suitable and rated for both Type 1 and Type 2 applications.
- .3 Maximum voltage protection rating to not exceed:
 - .1 700 V (120/208 V) or 1500 V (600/347 V): L-N, L-G, N-G.
 - .2 1200 V (120/208 V) or 3000 V (600 V): L-L.
- .4 Minimum Nominal Discharge Current Rating: 10 kA.
- .5 Minimum Short Circuit Current Rating: 100 kA.
- .6 Minimum Surge Current for Low Voltage Switchgear: 240 KA per phase (120 KA per mode).
- .7 Minimum Surge Current for Low Voltage Switchboards: 120 KA per phase (60 KA per mode).
- .8 Minimum Surge Current for Low Voltage Panelboards: 50 KA per phase (25 KA per mode).
- .9 Peak Surge Current for Low Voltage Switchgear and Switchboards: 250 KA per phase.

- .10 Peak Surge Current for Distribution Panelboards: 150 KA per phase.
- .11 Peak Surge Current for Branch Circuit Panelboards: 100 KA per phase.
- .12 EMI/RFI Filtering Attenuation: Up to 50 dB from 10 kHz to 100 MHz.

2.03 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 SPDs:
 - .1 Eaton.
 - .2 Schneider.
 - .3 Siemens Electric.

3. Execution

3.01 INSTALLATION OF SPDS

- .1 Obtain training from manufacturer representative on special installation procedures. Install units in accordance with manufacturer instructions.
- .2 Coordinate installation with manufacturer of equipment to which SPDs are connected. For switchgear or switchboards, coordinate configuration, accommodating dedicated front facing cell or main breaker compartment for installing SPD units for applications of integral mounting. Install dedicated breaker device of type and rating in accordance with SPD manufacturer requirements. Mount SPD units such that connecting conductors to dedicated breaker do not exceed length in accordance with SPD manufacturer requirements.
- .3 Where internally mounted in equipment, mount SPD units so that MOV condition LED indicator is visible from front of respective switchgear, switchboard or panelboard.
- .4 Where retrofitting to existing switchboards/panels, mount externally as close as possible in accordance with connecting conductor length limitations of SPD manufacturer and connect with breaker.
- .5 Connect and make incoming and outgoing power cable connections to equipment in accordance with equipment manufacturer recommendations. Check wire range on lugs for SPD, verifying that wire size and number of conductors being connected are within range of lugs.
- .6 Provide alarm and communications circuits. Integrate equipment to Division 25 BAS. Extend wiring in conduit to interconnection terminal cabinet. Provide wiring in conduit from cabinet to respective BAS panel serving area. Make connections. Coordinate requirements with respective equipment vendors and work of Division 25.
- .7 Ground and bond components.

3.02 IDENTIFICATION

- .1 Provide product identification.
- .2 Nameplates: Size 4, unless otherwise noted.

3.03 FIELD QUALITY CONTROL

- .1 Include for manufacturer representative to inspect, test, and commission installed equipment.

- .2 Inspection, Start-up, Testing and Verification:
 - .1 Inspect, start-up, test and verify products.
 - .2 Check connections and operations.
 - .3 In accordance with manufacturer recommendations, do not perform hi-pot testing (meggering) of cabling or other equipment, with SPDs connected.
 - .4 Test units in accordance with manufacturer recommendations.
- .3 Prepare testing and verification reports signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI):
 - .1 ANSI C78.377-[2017(R2022)], Electric Lamps - Specifications for the Chromaticity of Solid-state Lighting Products.
- .2 American National Standards Institute (ANSI)/Illuminating Engineers Society (IES):
 - .1 ANSI/IES LM-79-[19], Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products.
 - .2 ANSI/IES LM-80-[21], IES Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
 - .3 ANSI/IES TM-21-[21], Technical Memorandum: Projecting Long-Term Lumen, Photon, and Radiant Flux Maintenance of Led Light Sources.
 - .4 ANSI/IES TM-30-[20], IES Method for Evaluating Light Source Color Rendition.
- .3 American National Standards Institute/Underwriters Laboratories (ANSI/UL):
 - .1 ANSI/UL 924-[2022], Standard for Emergency Lighting and Power Equipment.
- .4 CSA Group (CSA):
 - .1 CSA C22.2 No. 250.13-[22], Light Emitting Diode (LED) Equipment for Lighting Applications.
- .5 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE C62.41.1-[2002(R2008)], IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
 - .2 ANSI/IEEE C62.41.2-[2002/Cor 1-2012], IEEE Recommended Practice on Characterization of Surges In Low-Voltage (1000 V And Less) AC Power Circuits.
- .6 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA 410-[2023], Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section, and on Schedule of Luminaires.
 - .2 Submittals include:
 - .1 Luminaire (lighting fixtures) dimensions, aperture dimensions, cut-out dimensions.

- .2 Driver information for each luminaire, including maximum circuit loading limitations, and dimming details.
 - .3 Total input watts.
 - .4 Lumen rating in accordance with IESNA testing procedures.
 - .5 Candlepower summary, candela distribution zonal lumen summary.
 - .6 Luminaire efficiency.
 - .7 Lamp life rating (in accordance with ANSI/IES LM-80 and ANSI/IES TM-21).
 - .8 Colour temperature.
 - .9 Colour fidelity (in accordance with ANSI/IES TM-30 preferred).
 - .10 Finishes.
 - .11 Options being provided.
 - .12 Other relevant information to verify design intent.
- .3 Poles Submittals:
- .1 Documentation that poles are suitable for steady wind velocity and gust velocity of area of installation.
 - .2 Documentation that poles are suitable for total effective projected area of mounted lighting equipment.
 - .3 Detail of pole construction, dimensions, finishes, mounting and bases where applicable.
 - .4 In-ground detail identifying depth, as applicable.
 - .5 For poles as noted, include Delegated Design submission of above submittals with detailed drawings of poles and bases, stamped and signed by Structural Professional Engineer experienced in pole design.
- .4 Exterior Site Areas or Parking Areas Submittals:
- .1 Luminaire manufacturer computer prepared detailed photometric layout drawings with complete photometry showing performance levels of proposed luminaires.
 - .2 Clearly identify lighting levels, quantity, locations, mounting heights and other performance data.
- .5 For interconnected products, submit manufacturer documentation verifying compatibility.
- .6 Submit testing and verification reports.

1.03 WARRANTY

- .1 Warranty requirements for luminaires are as follows:
- .1 Full comprehensive product replacement direct from luminaire manufacturers.
 - .2 When lighting emitting diodes (LEDs) and drivers are supplied with luminaire-by-luminaire manufacturer, warranty is responsibility of luminaire manufacturer.
 - .3 Warrant LED luminaires and drivers for period of minimum 5 years. Include for personnel, equipment and labour for replacing products onsite, for duration of contract warranty period. For remainder of 5 years extended warranties beyond contract warranty period, include typical conditions of product manufacturer replacement warranty.

1.04 PRODUCT COMPATIBILITY

- .1 Provide luminaires 100% compatible with lighting controls, when integrated together for control purposes. Refer to Section 26 09 23 - Lighting Control Devices or Section 26 09 44 - Digital Network Lighting Control Systems, as applicable.
- .2 Coordinate with driver and LED manufacturers, LV relay panel manufacturers, switch/timer manufacturers and dimmer/light sensor/occupancy control manufacturers to verify that components are compatible with each other and that interconnections do not adversely affect performance, life or warranties.
- .3 Submit manufacturer documentation verifying compatibility.

1.05 SUBSTITUTIONS

- .1 Provide luminaires as specified. During construction period, no substitutions are permitted unless compelling reasons are given and accepted by Owner and reviewed with Consultant. Delay caused by Contractor failure to order luminaires to meet construction schedule, is not a valid reason.
- .2 Make requests for proposed substitutions in accordance with Specification requirements. In addition, make payments for additional costs to Consultant for these reviews, based on amount of \$250 per luminaire type, and per submission.
- .3 Consideration of proposed substitutions after Bid Period is at Consultant sole discretion.

2. Products

2.01 LUMINAIRES

- .1 Provide luminaires in accordance with Luminaire Schedule.
- .2 Features:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 Certified and tested with LEDs and drivers as complete assembly.
 - .3 Prior to shipping to site, test luminaires and integrated LEDs and drivers, for full compatibility operation.
 - .4 Provide thickness of metal as noted in Luminaire Schedule and details, or as required so that luminaires are rigid, stable and resists deflection, twisting, warping or bending under normal installation procedures, re-lamping and maintenance and cleaning.
 - .5 Linear and continuous linear architectural LED luminaires bodies constructed of extruded aluminum and of rigid construction, unless otherwise noted.
 - .6 Body finishes of corrosion-resistant, chemically treated and electrostatically applied powder coat finish, unless otherwise noted.
 - .7 Vandal-resistant luminaires constructed of heavy-duty extruded aluminum with stainless steel tamperproof head set screws and lens of extruded UV stabilized polycarbonate, unless otherwise noted.
 - .8 Neoprene or silicone gasketing, barriers and stops preventing light leaks or water/water vapour penetration, unless otherwise noted.
 - .9 Fabricated housings allowing for easy accessibility and replacement of parts.
 - .10 Fabricated Luminaires:
 - .1 Minimum number of joints.
 - .2 Unexposed joints made by welding, brazing, screwing or bolting. Soldered joints are not acceptable.

- .3 Do not use blind metal tapping methods or rivets for fastening parts need removal during service, or for fastening electrical components and supports.
- .4 Cast parts including die-cast members, of uniform quality, close grained, rigid, true to pattern, free from blow holes, pores, discoloration, hard spots, shrinkage defects, and cracks or other imperfections affecting strength and appearance or indicative of inferior metals or alloys.
- .11 Reflectors and reflecting cones or baffles free of tooling marks, spinning lines or marks by other assembly techniques.
- .12 Lenses and louvers in accordance with building code flame spread rating requirements.
- .13 Recessed luminaires with replaceable/serviceable parts accessible from lens side (room side) of luminaires allowing for proper accessibility.
- .14 Exposed parts and hardware of luminaires located in non-climate-controlled areas:
 - .1 Corrosion-resistant and weather-resistant.
 - .2 Tamper-resistant hardware.
- .15 Exterior Poles:
 - .1 Exterior luminaire poles with corrosion-resistant finish and construction.
 - .2 Poles structurally suitable withstanding steady wind velocity and gust velocity of area of installation, and suitable for total effective projected area of lighting equipment.
- .3 Include following for assembly and mounting of luminaires:
 - .1 Wiring and connectors.
 - .2 Fittings and hangers.
 - .3 Aligners.
 - .4 Box covers.
 - .5 Other accessories for complete, safe and fully operational assembly.
 - .6 Provide additional seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and luminaire manufacturer recommendations.
- .4 Where luminaires are of same or similar types, provide from same manufacturer. Maintain uniformity of manufacturer for groups of luminaires intended to be part of same aesthetic family.

2.02 LIGHT EMITTING DIODES (LEDs) AND DRIVERS

- .1 General Features:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 In accordance with:
 - .1 ANSI/IES LM-79 and ANSI/IES LM-80.
 - .2 CSA C22.2 No. 250.13.
 - .3 NEMA 410.
 - .3 Typical Operating Temperatures:
 - .1 Luminaires for applications in extreme cold, non-climate-controlled area: Operating temperature range through minus 40°C to 60°C.

- .2 Luminaires for applications in climate-controlled area: Operating temperature range through minus 20°C to 50°C.
- .4 Where connected to dimmers, are 100% compatible with connected dimmer controls, providing dimming down to 1%.
- .5 Review with dimming controls vendors, verifying technical operations of dimmers such as forward phase or reverse phase, match and are compatible with LED/driver technology.
- .2 LED Features:
 - .1 LEDs selected from same colour bin size for consistency in chromaticity and in accordance with ANSI C78.377.
 - .2 Colour Temperature Range:
 - .1 Typically, 2700 K to 6500 K.
 - .2 Specific temperature requirements identified on Luminaire Schedule.
 - .3 CRI: At least 85, unless otherwise noted.
 - .4 Rated life: In accordance with ANSI/IES LM-80 and ANSI/IES TM-21, minimum 50,000 hours.
- .3 Driver Features:
 - .1 Operate from 60 Hz input source of 120 VAC/347 VAC (as applicable) with sustained variations of $\pm 10\%$ (voltage and frequency) with no damage to driver.
 - .2 Output Regulated: $\pm 5\%$ across load range.
 - .3 Power Factor: Greater than 0.90.
 - .4 Total Harmonic Distortion: Less than 20%.
 - .5 Class A sound rating.
 - .6 In accordance with IEEE C62.41.1 Category A for transient protection.

2.03 SYSTEMS SIGNAGE

- .1 Illuminated Signage:
 - .1 Specified on Luminaire Schedule.
 - .2 Signage of type that wording is visible when sign is illuminated.
 - .3 Prior to ordering, review nomenclature and colour of display (LEDs or illuminated panels) with Consultant.

2.04 FINISHES

- .1 Luminaire Finishes:
 - .1 In accordance with Luminaire Schedule.
 - .2 Exposed parts and hardware of luminaires located in non-climate-controlled areas: Corrosion-resistant and weather-resistant.
 - .3 Reviewed with Consultant with samples and shop drawing submissions.

2.05 OPTICAL CONTROL DEVICES

- .1 Provided integral devices with luminaire, by luminaire manufacturer, unless otherwise noted.
- .2 Refer to Luminaire Schedules.
- .3 Where remote from luminaires, refer to Section 26 09 23 - Lighting Control Devices.

2.06 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Luminaires:
 - .1 Refer to Luminaire Schedule.
- .2 LEDs:
 - .1 Cree.
 - .2 Nichia.
 - .3 Lumileds.
 - .4 Toshiba.
 - .5 Samsung.

3. Execution

3.01 LUMINAIRES SUPPLIED BY OTHERS

- .1 Designated luminaires as noted are supplied by Owner or under another Division of Work. Include in Bid, Work and materials, accommodating such luminaires, including:
 - .1 Receiving and inspecting luminaires.
 - .2 Complete installation.
 - .3 Providing installation hardware to complete installation, and not supplied by luminaire manufacturer.
 - .4 Aiming and connecting.
 - .5 Providing power feeders, control wiring, conduit and electrical boxes.
 - .6 Cleaning, adjusting and testing.
 - .7 Providing lamps where noted as not supplied with luminaire.
 - .8 Providing power connections and where luminaires are controlled via remote low voltage controller, include installation of controller and providing low voltage wiring in conduit and connections.
 - .9 Coordinating requirements with supplier of luminaires and reviewing with Consultant prior to installation.

3.02 INSTALLATION OF LUMINAIRES

- .1 Unless otherwise noted, do not use dimensions noted on electrical drawings for linear and continuous linear LED luminaires for sizing luminaires.
- .2 Unless otherwise noted, do not use dimensions noted on electrical drawings for architectural elements such as coves, valances, linear and continuous linear LED luminaires for sizing luminaires. Refer to Architectural drawings.
- .3 Measure installation locations for exact dimensions prior to fabrication.
- .4 Before placing luminaire orders:
 - .1 Review Consultant reviewed shop drawings and address comments.
 - .2 Verify quantity requirements.
 - .3 Review ceiling types, finishes and construction details. Verify ceiling types with architectural drawings.
 - .4 Verify type of mounting assemblies, frames, rings and ancillary devices for installation.

- .5 Review colours and finishes with Consultant.
- .5 Obtain training from manufacturer representative on special installation procedures. Install products in accordance with manufacturer instructions.
- .6 Prior to roughing-in, review final locations of luminaires with Consultant.
- .7 Locate and install luminaires into positions.
- .8 Provide supports suiting ceiling system.
- .9 Reference electrical drawings for general luminaire location, circuiting, and controls. Reference Architectural reflected ceiling plans (RCPs) for more detailed location of luminaires. Consult both sets of drawings in preparation for installation. Install luminaires in accordance with reflected ceiling plans, wall elevations, and field instructions issued by Consultant.
- .10 In equipment rooms, shafts and similar secondary areas, install luminaires after mechanical and other major work is roughed-in and adjust luminaire locations to suit.
- .11 Include for assembly and mounting of luminaires and lamps, with:
 - .1 Wiring and connections.
 - .2 Fittings and hangers.
 - .3 Aligners.
 - .4 Box covers.
 - .5 Other accessories for safe and fully operational assembly.
- .12 Where outlet box locations are noted, they are diagrammatic only. Position outlet boxes, coinciding with suspension hangers and knockouts.
- .13 Install ceiling luminaires in centre of tiles, unless dimensioned otherwise on Reflected Ceiling Plans. Locate hangers on tile centres or intersections. Mount recessed downlights, troffers, and surface mounted luminaires in or on full tiles. Install luminaires in and on acoustical tile ceilings in alignment with tile joints.
- .14 Cut holes for recessed luminaires to size so that gaps are not visible, or luminaire trims cover gaps.
- .15 Mount surface ceiling luminaires level or plumb, tightly to ceiling without showing space or light leak between frame and ceiling.
- .16 Align linear luminaires indicated in continuous lines or rows, so that rows appear as straight lines. Variation in alignment not to exceed 6 mm for 5 m runs.
- .17 Align luminaires mounted individually parallel or perpendicular to building grid lines unless otherwise noted.
- .18 Provide spacers for luminaires mounted on low density ceiling material.
- .19 Provide plaster frames for recessed luminaires in plaster or gypsum board ceilings.
- .20 Prepare luminaires, trim and poles and standards requiring onsite painting.
- .21 Connect luminaires to lighting circuits.
- .22 Protect wiring with tape or tubing at points where abrasion occurs. Conceal wiring within luminaire construction unless design or mounting dictates otherwise.
- .23 Splices:
 - .1 Minimize number of splices.

- .2 Make with mechanical insulated steel spring type connectors, suiting temperature and voltage conditions to which splices are subjected.
- .3 Mask splices properly terminated in accessible identified junction boxes.
- .24 Support luminaires directly by ceiling slab structure and not to formed steel decking, ceiling hangers, ductwork, piping, cable trays, or other similar materials. Prior to start of work, review requirements with Consultant.
- .25 Do not tighten wing nuts, bolts, or screws that allow luminaire adjustment for recessed adjustable luminaires.
- .26 Install spread lenses where noted.
- .27 Use cloth gloves when handling reflector cones, louvers, lamps, glass, sconces and exposed surfaces of luminaires.
- .28 Co-ordinate luminaire installation with work of other trades, providing recessing depths and mounting spaces.
- .29 Align and position adjustable luminaires and position luminaires with adjustable optics or adjustable lamp holders corresponding to LEDs or lamps.
- .30 Comply with requirements of electrical code regarding support of luminaires in suspended ceilings.
- .31 Provide IC-rated luminaires where recessed installed in insulated ceilings.
- .32 Independently suspend luminaires in suspended ceilings from ceiling slab. Unless otherwise noted for each luminaire, provide minimum two cable supports secured to ceiling slab and to luminaire.
- .33 Connect luminaires to power circuits and controls. Circuit for both normal and emergency power circuits as noted. Refer to Section 26 09 23 - Lighting Control Devices, for related controls work.
- .34 For emergency lighting controls, provide relays compliant with ANSI/UL 924 and electrical code requirements.
- .35 Notify Consultant of following conditions:
 - .1 Insufficient ceiling space.
 - .2 Luminaire placement conflicts with structural beam, mechanical duct, plumbing pipe, or other obstructions.
 - .3 Luminaire placement does not allow access for service and maintenance.
 - .4 Luminaire cannot be located where dimensioned or noted on drawings.
- .36 Existing luminaires designated for relocation and reuse:
 - .1 Disconnect, remove and store in area as reviewed with Consultant, until ready for re-installation.
 - .2 Inspect and clean.
 - .3 Identified to Consultant, of requirement for replacement parts for broken lenses, faulty ballasts/drivers, broken mounting hardware, lamps not working, in order to return luminaires to working conditions.
 - .4 Repair and re-lamp, as required.
- .37 Secure grade mounted building floodlighting luminaires to concrete pads set flush with finished grade level.
- .38 Provide seismic restraints as specified.

- .39 Ground and bond luminaires.
- .40 Energize installed luminaires for testing of installation, and de-energized until system commissioning. Do not use installed luminaires for construction lights.
- .41 Retain protective material on luminaires (remove as required for testing), until prior to commissioning.
- .42 Demonstrate operation of luminaires intended for special applications such as building floodlights and other decorative purposes. Adjust their locations within reasonable distance, obtaining desired effects.
- .43 Identify circuits and components as specified, and in manner reviewed with Consultant.
- .44 Prior to turn over of Work, clean luminaires in manner recommended by manufacturer, and as reviewed with Consultant.
- .45 Provide lamps in new condition and intact when project is complete and ready for acceptance.
- .46 Include full LED/lamp listing in Operating and Maintenance Instruction Manuals.

3.03 INSTALLATION OF POLES

- .1 Engage Delegated Design Professional Structural Engineer to review and endorse final pole design.
- .2 Provide poles for luminaires as noted.
- .3 Install in accordance with manufacturer instructions, drawing details and requirements of AHJ.
- .4 Concrete Bases:
 - .1 Secure poles for pole mounted exterior type luminaires to concrete bases. Refer to drawing detail for general requirements and prepare detailed drawing identifying specific requirements for intended applications.
 - .2 Co-ordinate work with trades providing excavation, backfilling and concrete work for bases.
 - .3 Provide anchor bolt covers and anchor bolt templates for proper positioning of anchor bolts in concrete.
 - .4 Include Professional Engineer to review and endorse final base design work.
- .5 Extend ground conductors from metal parts of poles to building grounding provisions. Provide grounding pits as detailed. Run wiring in conduit.

3.04 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing and Verification:
 - .1 Inspect, start-up, test, adjust and verify products.
 - .2 Check connections and operations.
 - .3 Check operations with controls.
 - .4 Test and adjust exterior luminaires at times after sunset, in presence of Consultant and at times reviewed with Consultant.
- .2 Where poles and bases are Delegated Design, arrange with Delegated Design Professional Engineer to review work of this Section and submit written reports verifying compliance with Contract Documents.

- .3 Prepare compliance certificates, testing and verification reports, signed by testing technician and Delegated Design Professional Engineer as applicable. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No.141-[15(R2020)], Emergency Lighting Equipment.
 - .2 CSA C282-[19], Emergency Electrical Power Supply for Buildings.
- .2 Institute of Electrical and Electronic Engineers (IEEE):
 - .1 IEEE C62.41.1-[2002(R2008)], IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
 - .2 IEEE C62.45-[2002(R2008)], IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits.
- .3 Underwriters Laboratories (UL):
 - .1 UL 1449-[2022], Standard for Surge Protective Devices.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit date that batteries have been stored and manufacturer maximum storage life.
- .4 Submit compliance certificates, and testing and verification reports.

1.03 WARRANTY

- .1 Units: Minimum 3 years warranty period.
- .2 Batteries:
 - .1 Life expectancy: Minimum 8 years.
 - .2 Minimum 3 years warranty period with full replacement.
 - .3 After initial 3 years warranty, additional minimum 3 years pro-rata warranty.
- .3 No deductible amounts.

2. Products

2.01 EMERGENCY LIGHTING BATTERY UNITS

- .1 Emergency Lighting Equipment: In accordance with CSA C22.2 No.141.
- .2 Supply Voltage: 120 VAC, unless otherwise noted.
- .3 Output Voltage: 12 VDC, unless otherwise noted.

- .4 Capacity and Battery Operating Runtime: Capacity to supply sufficient output power to lamp loads and to connected exit sign emergency loads for period in accordance with requirements of building code, but not less than minimum of [30] minutes runtime at full capacity of unit. Also include in capacity for limits on loading of circuits as specified in Part 3.
- .5 With batteries, charger, integral lamp heads, cabinet, tamper-proof hardware, 1.2 m long AC cord and twist lock plug set, and accessories.
- .6 Batteries: Long-life, sealed and maintenance free. Designed for at least 10 years of life expectancy.
- .7 Charger and Control Unit:
 - .1 Automatic, solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.
 - .2 Units automatically and instantaneously energizes lamp load upon failure of AC supply.
 - .3 Battery protection circuit automatically shuts down lamp load when battery reaches full discharge.
 - .4 Chargers fully recharge battery in 12 to 24 hours and be current limited and short circuit proof.
 - .5 Units include test switch and status indicator light.
 - .6 Solid state transfer circuit.
 - .7 Low Voltage Disconnects: Solid state, modular, operates at 80% battery output voltage.
 - .8 Signal Lights: Solid state, for AC Power ON and High Charge.
 - .9 Automatic testing and self-diagnostic circuitry, and remote monitoring functions.
- .8 Cabinet:
 - .1 Suitable for direct or shelf mounting to wall.
 - .2 Constructed of No. 18 gauge steel and complete with knockouts for conduit entries.
 - .3 Removable or hinged front panel for easy access to batteries.
 - .4 Finished in white enamel with corrosion-resistant undercoating.
- .9 Integral Lamp Heads:
 - .1 345 degrees horizontal and 180 degrees vertical adjustment
 - .2 6 W MR16 LED lamps, decorative design, high impact plastic, adjustable heads.
- .10 Remote Lamp Heads:
 - .1 With 6W LED lamps providing greater than 590 lumens output each.
 - .2 Remote Surface Mounted Vandal-Resistant Heads in Climate Controlled Areas:
 - .1 Vandal resistant, heavy duty, completely enclosed units with overall clear, UV resistant polycarbonate lens cover, die cast aluminum back plate, single and double adjustable head, with 12 V, 6 W MR16 LED lamps.
 - .3 Remote Surface Mounted Heads in Climate Controlled Areas:
 - .1 Single, double or triple adjustable swivel injection moulded, fire retardant thermoplastic heads and stem.

- .2 12 V, 6 W MR16 LED lamps.
- .4 Remote Surface Mounted Heads in Non-Climate Controlled Areas:
 - .1 NEMA 4X certified, weather-proof, vandal resistant completely enclosed units.
 - .2 Fully gasketed cast aluminium back plate.
 - .3 Overall polycarbonate lens cover.
 - .4 Single and double adjustable heads.
 - .5 12 V, 6 W MR16 LED lamps.
 - .6
- .11 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 or wall bracket to suit installation requirements.
 - .8 RFI suppressors.
 - .9 Wire Guards: Enamel painted steel or aluminum construction and as noted.
 - .10 Polycarbonate Covers: Clear, impact resistant and as noted.
 - .11 Provide additional supports and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and equipment manufacturer recommendations.

2.02 T-BAR CEILING EMERGENCY LIGHTING UNITS

- .1 Units for flush mounting in T-bar type suspended ceilings. Units complete with integral lamp heads, batteries, charger, recessed housing and T-bar ceiling mounting hanger assembly.
- .2 Emergency Lighting Equipment: In accordance with CSA C22.2 No.141.
- .3 Supply Voltage: 120 VAC, unless otherwise noted.
- .4 Output Voltage: 12 VDC for integral heads, unless otherwise noted.
- .5 Operating Runtime: Capacity to supply sufficient output power to lamp loads and to connected exit sign emergency loads for period in accordance with requirements of building code but not less than minimum of [30]minutes at full capacity of unit. Also include in capacity for limits on loading of circuits as specified in Part 3.
- .6 Batteries: Long-life, sealed, maintenance free. Designed for at least 10 years of life expectancy.
- .7 Charger and Control Unit:
 - .1 Automatic, solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.
 - .2 Units automatically and instantaneously energizes lamp load upon failure of AC supply.

- .3 Battery protection circuit automatically shuts down lamp load when battery reaches full discharge.
- .4 Chargers fully recharge battery in 12 to 24 hours and be current limited and short circuit proof.
- .5 Units include test switch and status indicator light.
- .6 Solid state transfer circuit.
- .7 Low Voltage Disconnects: Solid state, modular, operates at 80% battery output voltage.
- .8 Signal Lights: Solid state, for AC Power ON and High Charge.
- .9 Automatic testing and self-diagnostic circuitry, and remote monitoring functions.
- .8 Housing:
 - .1 Backboxes are constructed of No. 20 gauge steel, finished in white enamel.
 - .2 Back cover removable, providing easy and full access to battery and charger connections.
 - .3 Front cover includes diagnostic indicator lights, test switch and provisions to mount light heads.
 - .4 Housing with batteries and charger are installed concealed above ceiling level.
- .9 Integral and Remote Surface-Mounted Lamp Heads in Climate-Controlled Areas:
 - .1 Decorative design, high impact plastic, adjustable units.
 - .2 Integral Heads: 12 V, 6 W MR16 LED lamps.
 - .3 Remote Heads: 12 V, 6 W MR16 LED lamps.
- .10 Lamps: Unless otherwise noted, 6 W LED types providing minimum 590 lumens output from each.

2.03 WIRING OF REMOTE HEADS

- .1 Conduit: Type EMT for applications as specified in Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Conductors: Type RW90 for applications specified in Section 26 05 19 - Low Voltage Conductors and Cables, sized as indicated on drawing and in accordance with manufacturer recommendations.

2.04 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Unit Equipment Emergency Lighting:
 - .1 ABB (Lumacell).
 - .2 ABB (Emergi-Lite).
 - .3 Beluce (Beghelli).
 - .4 ABB (Ready-Lite).
 - .5 AimLite.

3. Execution

3.01 INSTALLATION OF EMERGENCY LIGHTING UNITS

- .1 Review with Consultant, voltage ratings of products and as required for project, verifying consistency throughout site.

- .2 Review battery storage dates and recharge as required to maintain manufacturer warranties. Replace batteries if storage date has been exceeded.
- .3 Obtain training from manufacturer representative on special installation procedures.
- .4 Install unit equipment and remote mounted fixtures. Install backboxes recessed in wall/ceiling construction, suiting intended applications.
- .5 For units installed in suspended ceilings, additionally independently secure to ceiling structure above suspended ceilings.
- .6 Install units such that units automatically actuate upon failure of power supply to normal lighting in area covered by that unit equipment.
- .7 Connection of battery units:
 - .1 To dedicated emergency circuit of local power panels designated for this purpose, as noted.
 - .2 To designated normal power circuits, as noted.
 - .3 Plugged into adjacent power receptacles, as noted.
 - .4 Direct connection to 347 V power circuits, as noted.
- .8 Connect exit signs to battery unit circuits in applications where exit signs require constant or backup DC supply.
- .9 Direct and aim adjustable and remote heads to illuminate areas as required.
- .10 Connect exit lights to unit equipment, where noted.
- .11 Coordinate receptacle requirements.
- .12 Do not load device circuits more than 80% capacity. Include for voltage drop requirements in accordance with manufacturer instructions.
- .13 Comply with requirements of AHJ with regards to providing fire-rated conductors (MI) for life safety applications.
- .14 Install wire guards or polycarbonate covers where noted.
- .15 Provisions for Generator Rooms:
 - .1 Provide room housing genset and automatic transfer switch with emergency lighting battery units and lamps providing minimum lighting level of 50 lux for period of minimum 2 hours, at equipment locations requiring service and adjustment.
 - .2 Provide circuit feeding battery unit with surge protective device (SPD) in accordance with following requirements:
 - .1 Battery unit manufacturer recommendations.
 - .2 CSA C282.
 - .3 IEEE C62.41.1 and IEEE C62.45.
 - .4 UL 1449.
 - .5 Maximum surge current of 125 kA/phase.

3.02 INSTALLATION OF EMERGENCY LED DRIVERS

- .1 Confirm compatibility of drivers with connected fixtures. Advise Consultant of compatibility and connection issues.
- .2 Install drivers in accordance with manufacturer instructions ensuring proper operations of both fixture and driver in regard to normal and emergency operations.

3.03 IDENTIFICATION

- .1 Provide product identification.
- .2 Battery Unit Nameplates: Size 4 engraved, unless otherwise noted.
- .3 Review nomenclature with Consultant.

3.04 FIELD QUALITY CONTROL

- .1 When installation of equipment is complete, and in conjunction with manufacturer technician:
 - .1 Inspect, start-up, test and verify products.
 - .2 Check connections and operations.
 - .3 Adjust and certify that system is complete, has been tested, adjusted, and is in proper operating condition.
 - .4 Test units and perform illumination level test, verifying compliance with building code requirements of illumination, path of egress and battery run times. Perform testing during night-time conditions. Document and verify equipment testing and verify that performance meets building code requirements.
- .2 Coordinate, arrange and obtain compliance certificates from manufacturer technician. Include copies with report.
- .3 Document and verify equipment testing performance is in accordance with building code requirements.
- .4 Prepare testing and verification reports signed by testing technician and manufacturer technician. Submit reports to Consultant.

END OF SECTION

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 141-[15(R2020)], Emergency Lighting Equipment.
 - .2 CAN/CSA-C860-[11(R2020)], Performance of Internally Lighted Exit Signs.
- .2 International Organization for Standardization (ISO):
 - .1 ISO 3864-1-[2011], Graphical Symbols - Safety Colours and Safety Signs – Part 1: Design Principles for Safety Signs and Safety Markings.
 - .2 ISO 7010-[2019/AMD8:2024], Graphical symbols - Safety Colours and Safety Signs – Registered Safety Signs - Amendment 5.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit data that batteries have been stored and manufacturer maximum storage life.
- .4 Submit compliance certificates and testing and verification reports.

2. Products

2.01 STANDARD EXIT SIGNS

- .1 Standards: In accordance with CSA C22.2 No. 141.
- .2 Housings: Extruded aluminum one-piece housing.
- .3 Faceplates: Extruded aluminum.
- .4 Lamps: Multiple white LEDs.
- .5 Operation: Designed for over 75,000 hours of continuous operation.
- .6 Energy Efficiency: Consumes less than 2.5 W.
- .7 Graphics: Green pictogram and white graphical symbol and directional arrows in accordance with ISO 3864-1. Dimensions in accordance with ISO 7010.
- .8 Faceplates: Remain captive for re-lamping.
- .9 Hardware: Tamperproof.
- .10 Mounting: Suitable for wall, ceiling or end mounting.
- .11 Canopy Mounts: Suited intended applications.
- .12 Voltage (as noted):
 - .1 Universal AC input: Two-wire 120 to 347VAC.
 - .2 Standard DC input: Two-wire 6 to 24VDC.

- .13 Wire Guards: Enamel painted steel or aluminum construction and as noted.
- .14 Polycarbonate Covers: Clear, impact resistant and as noted.

2.02 FINISHES AND OTHER FEATURES

- .1 Climate-controlled Areas: Selected from manufacturer standard finishes.
- .2 Non-climate-controlled Areas:
 - .1 Corrosion-resistant finishes.
 - .2 Corrosion-resistant and tamper-resistant exposed hardware.
- .3 Prior to ordering, review finishes with Consultant.

2.03 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Exit Signs:
 - .1 ABB (Lumacell).
 - .2 ABB (Emergi-Lite).
 - .3 BeLuce (Beghelli).
 - .4 ABB (Ready-Lite).
 - .5 AimLite.

3. Execution

3.01 INSTALLATION

- .1 Review with Consultant, voltage ratings of products and as required for project, verifying consistency throughout site.
- .2 Review battery storage dates of units with batteries and recharge as required to maintain manufacturer warranties. Replace batteries if storage date has been exceeded.
- .3 Provide exit signs specified in this Section and on Luminaire Schedules. Review installation locations and directional arrows with Consultant.
- .4 Verify that exit sign voltage ratings are consistent with project design requirements as noted. Advise Consultant of discrepancies.
- .5 Install exit signs and lights in accordance with manufacturer recommendations and building code requirements.
- .6 Review each respective installation location and determine installation accessories suiting support from either wall or ceiling construction. Provide brackets and stem assemblies. Review with Consultant.
- .7 Install exit signs in locations. Connect to power circuits. Where applicable for emergency power requirements, connect to emergency battery units. Relocate exit sign and re-direct direction arrows, suiting AHJ requirements and directions.
- .8 Exit signs suspended from ceiling installations:
 - .1 Mount signs with stem assembly from ceiling structure and provide assembly that connects to sign frame directly (not with electrical box mounted onto frame).

- .2 Provide continuous, no smaller than 13 mm threaded conduit (finished painted as reviewed with Consultant) extending from ceiling mounted junction box, with ball align hanger to threaded connector directly mounted into top of specified exit sign.
- .3 For suspended ceiling applications, secure signs also independently to ceiling slab above suspended ceilings.
- .9 Connect exit signs to dedicated exit sign/light circuits.
- .10 Connect emergency power provisions to emergency circuits of units.
- .11 Lock exit light circuit breaker in ON position.
- .12 For units with integral lighting heads, direct adjustable heads to illuminate areas.
- .13 Do not load device circuits more than 80% capacity. Notify Consultant where any circuits are overloaded. Include for voltage drop requirements in accordance with manufacturer instructions.
- .14 Install wire guards or polycarbonate covers where noted.

3.02 FIELD QUALITY CONTROL

- .1 When installation of equipment is complete, and in conjunction with manufacturer technician:
 - .1 Inspect, start-up, test and verify products.
 - .2 Check connections and operations.
 - .3 Adjust and certify that system is complete, has been tested, adjusted, and is in proper operating condition.
 - .4 Units with Lighting Heads: Additionally, test by performing illumination level test, verifying compliance with building code requirements. Test units and perform illumination level test, verifying compliance with building code requirements of illumination, path of egress and battery run time. Perform testing during night-time conditions. Document and verify equipment testing and verify that performance is in accordance with building code requirements.
- .2 Coordinate, arrange and obtain compliance certificates. Include copies with report.
- .3 Document and verify equipment testing performance is in accordance with building code requirements.
- .4 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 130-[16(R2021)], Requirements for Electrical Resistance Trace Heating and Heating Device Sets.
- .2 Institute of Electrical and Electronics (IEEE):
 - .1 IEEE 515-[2017], IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Industrial Applications.
 - .2 IEEE 515.1-[2022], Working Group for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Commercial Applications.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include:
 - .1 Ratings.
 - .2 Operating instructions.
 - .3 Controller/power wiring diagram.
 - .4 Proposed drawing layout of heating cables.

2. Products

2.01 GENERAL

- .1 Unless otherwise noted, engage system manufacturer authorized technician to assist in design and layout of each pipe being heat traced.
- .2 Refer to Mechanical Division drawings for additional specific information on piping being traced.

2.02 ELECTRIC HEATING CABLING SYSTEM FOR PIPE TRACING - SELF-REGULATING – STANDARD APPLICATIONS

- .1 Self-regulating electric heat tracing cable as follows:
 - .1 CSA certified, ULC listed and labeled.
 - .2 In accordance with CSA C22.2 No. 130.
 - .3 Compatible with piping being heated, as verified by heating cable manufacturer.

- .4 Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.
- .5 Terminated with waterproof, factory-assembled, non-heating leads with connectors at one end, and sealing of opposite end with watertight end seal.
- .6 Cable capable of crossing over itself without overheating.
- .7 Electrical Insulating Jacket: Flame-retardant modified polyolefin.
- .8 Ground Braid: Tinned-copper braid, minimum 70 percent for ground path and mechanical ruggedness.
- .9 Polyolefin inner jacket providing mechanical protection.
- .10 Outer Jacket:
 - .1 Above ground freeze protection of water lines where fuel oil or aqueous chemicals are not present: Modified polyolefin with ultraviolet inhibitor.
 - .2 Below-grade applications, grease waste, or where fuel oil or aqueous chemicals are present: Fluoropolymer with ultraviolet inhibitor.
 - .3 Printed with cable model number, agency listings, batch number, and meter marks.
- .11 Maximum Operating Temperature (Power On): Standard applications 65°C.
- .12 Maximum Exposure Temperature (Power Off): 65°C.
- .13 Self-Regulating Factor:
 - .1 At least 90% for low wattage rating series cable or at least 70% for higher wattage rating cables.
 - .2 Defined as percent reduction of heating cable power output going from 4°C pipe temperature to 65°C pipe temperature.
- .14 Cable operates at voltages noted, without use of transformers.
- .15 Wattage Rating: As noted, suiting intended applications as confirmed with cable manufacturer.
- .2 Wattage of selected heating cable based on manufacturer recommendations (design table or design software program), at noted voltage, pipe lengths, insulation thickness, scheduled connected panelboard breakers and minimum start-up ambient temperature, suiting site intended applications.
- .3 Components exposed to elements are weatherproof and corrosion-resistant. Component enclosures are NEMA 4X rated.
- .4 Control Units: Controllers listed later in this Section.
- .5 Accessories:
 - .1 Heating cable gland kit.
 - .2 Power connection and end seal kits.
 - .3 Splice, end seal and tee kits.
 - .4 "Electric Traced" pipe labels.
 - .5 Aluminum tape for plastic pipe.
 - .6 Glass cloth adhesive tape for metal pipe.
 - .7 Contactors and relays, and mounting hardware.
- .6 Warranty:
 - .1 Manufacturers standard warranty on products except for cabling.

- .2 Minimum 10-year product limited warranty on cable.

**2.03 ELECTRIC HEATING CABLING SYSTEM FOR PIPE TRACING - SELF-REGULATING
– HIGH TEMPERATURE STEAM CLEANING APPLICATIONS**

- .1 Self-regulating electric heat tracing cable as follows:
 - .1 CSA certified, ULC listed and labeled.
 - .2 In accordance with CSA C22.2 No. 130.
 - .3 Compatible with piping being heated, as verified by heating cable manufacturer.
 - .4 Heating Element: Pair of parallel No. 14 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.
 - .5 Terminated with waterproof, factory-assembled, non-heating leads with connectors at one end, and sealing of opposite end with watertight end seal.
 - .6 Cable capable of crossing over itself without overheating.
 - .7 Electrical Insulating Jacket: Flame-retardant fluoropolymer.
 - .8 Ground Braid: Tinned-copper braid, minimum 70% for ground path and mechanical ruggedness.
 - .9 Polyolefin inner jacket providing mechanical protection.
 - .10 Outer Jacket:
 - .1 Fluoropolymer with ultraviolet inhibitor.
 - .2 Printed with cable model number, agency listings, batch number, and meter marks.
 - .11 Maximum Operating Temperature (Power On): Standard applications 121°C.
 - .12 Maximum Intermittent Exposure Temperature (Power On/Off): 250°C.
 - .13 Self-regulating Factor:
 - .1 Defined as rate of change of power output of heating cable as measured between 10°C and 38°C.
 - .2 From 0.068 W/m for lower wattage series cable to at least 0.180 W/m for higher wattage series.
 - .3 Cable produces less than 1.64 W/m when energized and heated to 177°C for 30 minutes. After this test, if cable reenergized, it does not have increasing power output leading to thermal runaway.
 - .14 Cable operates at voltages noted, without use of transformers.
 - .15 Wattage Rating: As noted, suiting intended applications as confirmed with cable manufacturer.
- .2 Wattage of selected heating cable based on manufacturer recommendations (design table or design software program), at noted voltage, pipe lengths, insulation thickness, scheduled connected panelboard breakers and minimum start-up ambient temperature, suiting site intended applications.
- .3 Components exposed to elements are weatherproof and corrosion-resistant. Component enclosures are NEMA 4X rated.
- .4 Control Units: Controllers listed later in this Section.
- .5 Accessories:
 - .1 Heating cable gland kit.
 - .2 Power connection and end seal kits.

- .3 Splice, end seal and tee kits.
- .4 "Electric Traced" pipe labels.
- .5 Aluminum tape for plastic pipe.
- .6 Glass cloth adhesive tape for metal pipe.
- .7 Contactors and relays, and mounting hardware.
- .6 Warranty:
 - .1 Manufacturers standard warranty on products except for cabling.
 - .2 Minimum 10-year product limited warranty on cable.

2.04 ELECTRIC HEATING CABLING SYSTEM FOR PIPE TRACING – MINERAL INSULATED TYPE

- .1 Mineral insulated (MI) heating cabling system, consisting of heating cable, control components, and installation and connection accessories.
- .2 MI Heating Cable:
 - .1 CSA certified.
 - .2 Magnesium oxide insulated, with copper or alloy conductor and sheath of nickel-iron-chromium alloy with additions of molybdenum and copper.
 - .3 Overall jacket of high-density polyethylene (HDPE) construction.
 - .4 Heating section of cable joined to cold section of required length and constructed of material consisting of nickel-iron-chromium alloy with additions of molybdenum and copper.
 - .5 Designed for operation on supply voltages up to 600 VAC.
 - .6 Maximum maintained temperature of 550°C.
 - .7 Maximum exposure temperature of 650°C.
 - .8 Corrosion-resistant and weather-resistant.
 - .9 Factory terminated and tested.
 - .10 Factory-fabricated to length required for pipe plus allowance for areas of additional heat loss and for field variations.
- .3 Components exposed to elements are weatherproof and corrosion-resistant. Component enclosures are NEMA 4X rated.
- .4 Mounting Hardware: Corrosion-resistant stainless-steel strapping of lengths suiting piping diameters and to secure cables in place.
- .5 Junction Boxes: Cast aluminum flush and surface mounting junction boxes with gasketed lid and entries suiting entries required at each location.
- .6 Controllers:
 - .1 System controlled by automatic controllers and sensors, as specified elsewhere in this Section.
 - .2 Include manual override switch of type recommended by system manufacturer to deactivate system power.
- .7 Accessories:
 - .1 System accessories for cable connections.
 - .2 "Electric Traced" pipe labels.
 - .3 Contactors and relays, as required.

2.05 STANDARD SINGLE POINT CONTROLLERS

- .1 Single circuit local digital controller with features as follows:
 - .1 CSA certified, ULC listed and labeled.
 - .2 LED window digital display of measured temperature, set points, and alarm conditions.
 - .3 Alarm conditions include temperature sensor failure, high or low temperature and ground fault.
 - .4 Status LED indicators.
 - .5 Integral 30 ma ground fault protection.
 - .6 Programmable temperature settings.
 - .7 Current rating up to 30 amperes.
 - .8 Alarm contacts and LED indicator.
 - .9 Non-volatile memory.
 - .10 Wall-mounting weatherproof NEMA 4X polycarbonate enclosure with protective impact-resistant, hinged open, locking clear lid cover.
 - .11 Thermistor sensor of length of 7 m.
 - .12 Pipe support bracket where mounted to pipe.

2.06 SINGLE POINT CONTROLLERS WITH BAS INTERFACE

- .1 Single circuit local digital controller with features as follows:
 - .1 CSA certified, ULC listed and labeled.
 - .2 Microprocessor-based.
 - .3 Compatible with selected heating cable.
 - .4 LED window digital display of measured temperature, set points, and alarm conditions.
 - .5 Alarm conditions include temperature sensor failure, high or low temperature and ground fault.
 - .6 2 temperature inputs.
 - .7 Built-in integrated adjustable ground fault protection device.
 - .8 Built-in self-test feature, verifying proper functionality of heating cable system.
 - .9 Configured for line-sensing, ambient sensing and mode that proportionally energizes power to heating cable, minimizing energy based on ambient sensed conditions.
 - .10 Communication and integration with various BAS via LonWorks, BACnet or Metasys protocols gateways. Coordinate with requirements of Division 25.
 - .11 Isolated alarm relays and dry contact relays for alarm annunciation back to BAS.
 - .12 Following failure modes are monitored by digital controller and reported back to BAS:
 - .1 Loss of supply power.
 - .2 Loss of control power.
 - .3 Ground-fault.
 - .4 Continuity or open circuit.
 - .5 Low temperature.

- .13 Resistance temperature detectors (RTD): 100 ohm, 3-wire platinum types in series with suitable length stainless steel flexible armoured copper extension wires and required connection accessories.
- .14 NEMA 4X fiberglass reinforced plastic enclosure with protective impact-resistant, hinged open, locking clear lid cover.
- .2 Where components are exposed to elements, provide weatherproof and corrosion-resistant.
- .3 Include software and programming, and system installation and mounting accessories.

2.07 MULTIPOINT CONTROL SYSTEM

- .1 Multipoint electronic control, monitoring and power relay system for heating cables.
- .2 System Features:
 - .1 CSA certified, ULC listed and labeled.
 - .2 Pre-programmed parameters to provide concurrent control for heating cables.
 - .3 User interface terminal for system user interface programming and monitoring of ground fault/current/temperature, with features:
 - .1 200 mm colour LCD display with touch screen functionality.
 - .2 Communications interfaces for RS-485, RS-232 and 10/100 Base-T Ethernet, BACnet and Lon Works to Modbus protocol gateways.
 - .3 Communicates with multiple power control panels.
 - .4 Power control panel for ground fault and line current sensing, alarming, switching (electromechanical relays) and resistance temperature detectors (RTD) inputs for multiple heat tracing circuits. Panels can be networked together to control up to 200 circuits.
 - .5 3-wire platinum resistance temperature detectors with suitable length stainless steel flexible armoured copper extension wire and connection accessories.
 - .6 Remote monitoring modules collect additional temperatures for control and monitoring of heat-tracing circuits by power control panels.
 - .7 Ancillary modules, devices and connection cabling, suiting intended applications and as recommended by system manufacturer.
 - .8 Software and programming.
 - .9 System pre-programmed with application settings, suiting intended applications of task. Configured for ON/OFF, ambient sensing and mode that proportionally energizes power to heating cable to minimize energy based on ambient sensed conditions.
 - .10 Integral calendar/clock for adjustable timed set points.
 - .11 USB port allows quick and easy software update. Separate offline software tool allow users to pre-program control system and transfer program via USB drive or Ethernet.
 - .12 System assigns up to 4 - RTD temperature or external temperature and moisture sensing device inputs per heat tracing circuit.
 - .13 System communicates with up to 16 - Remote Monitoring Modules.
 - .14 Programmable alarm contacts including alarm light on enclosure covers.
 - .15 Configurable alarm settings for local and remote annunciation of:
 - .1 Loss of supply and control power.
 - .2 High/low temperatures.

- .3 Ground fault.
- .4 High/low current fault.
- .5 Continuity or open circuit.
- .6 Power consumption.
- .7 RTD failure.
- .16 Operating at line voltage as noted, suiting intended applications.
- .17 Operating temperature between minus 25°C to 50°C.
- .18 Sensor inputs.
- .19 Automatic self-testing ground fault equipment protection, with selectable settings for ground fault tripping.
- .20 Weatherproof NEMA 4 enclosures with protective impact-resistant, hinged open, locking clear lid cover. Components exposed to elements are weatherproof and corrosion-resistant.
- .21 System installation and mounting accessories.

2.08 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Self-Regulating Heat Tracing Cable Systems:
 - .1 nVent (Raychem).
 - .2 Thermon (3M).
- .2 MI Heat Tracing Cable Systems:
 - .1 nVent (Pyrotenax).
 - .2 Thermon (3M).
- .3 Controllers:
 - .1 nVent.
 - .2 Environmental Technologies.

3. Execution

3.01 INSTALLATION

- .1 Provide heat tracing products for piping of fire suppression, plumbing, and HVAC applications. Refer to other applications where noted.
- .2 Review documents to verify that requirements are included for proper operation and functionality of system for specific application in accordance with issued Documents. Confirm type of piping, length and diameter of piping, insulation, and design temperature parameters. Provide components suitable for operation at voltages and for connection to breakers as noted.
- .3 Obtain training from manufacturer representative on installation procedures. Install products in accordance with manufacturer recommendations and instructions.
- .4 Install heating cables in accordance with respective requirements of IEEE 515 and IEEE 515.1.
- .5 After successful pressure testing of pipe, apply heating cable linearly (without spiralling) on pipe. Secure heating cable to pipe. Coordinate installation with work of Mechanical Divisions and installation of pipe insulation.

- .6 Terminate cables with end terminations rated and recommended by cable manufacturer for respective cable types. Protect cable ends from moisture ingress until cable is terminated.
- .7 Do not exceed system manufacturer recommended maximum loading limits per circuit.
- .8 Protect heating cable from damage during installation. Replace damaged cables in full runs.
- .9 Provide junction boxes of type and size suiting application and as approved by system manufacturer. Locate junction boxes in accessible areas. Covers boxes when not working therein.
- .10 In applications where controller/thermostat does not have ground fault protection, connect pipe tracing power feeders to ground fault type breakers with trip set in accordance with system manufacturer recommendation and electrical code requirements.
- .11 Provide contactors/relays, connecting thermostats and cables and energizing/de-energizing heating cable circuits through thermostat operations.
- .12 Install controls, sensors, or thermostats and identify with nameplates. Set thermostats to manufacturer recommended upper limit temperature, ensuring that heating cable is totally de-energized above set point. Provide thermostats as noted. Where not noted, provide one for each commonly grouped cable (such as in same area and performing similar application).
- .13 Provide sensors in exposed or elevated locations and of type suiting intended application, and site conditions.
- .14 Engage system manufacturer authorized representative to program controllers and thermostats.
- .15 Review with Owner, requirement for remote manual override switch. Install in single gang electrical outlet box, with faceplate and connect with wiring.
- .16 Fire Alarm System Interconnections:
 - .1 Provide alarm/communications circuits. Provide conduits, boxes and control/signal wiring for interconnection to fire alarm system.
 - .2 Coordinate with fire alarm system vendor on location of panel used for interconnection of monitoring points and extend wiring in conduit from system heat tracing controls to location.
 - .3 Terminate wiring in junction box leaving 3 m of slack length of wiring (exact length coordinated suiting system connections), for extending and termination to fire alarm panel.
 - .4 Identify wiring and junction box.
- .17 BAS Interconnections:
 - .1 Provide alarm/communications circuits. Provide conduits, boxes and control and signal wiring for interconnection to Division 25 BAS.
 - .2 Coordinate with BAS vendor on location of BAS panel used for monitoring points and extend wiring in conduit from heat tracing controls to location.
 - .3 Terminate wiring in junction box leaving 3 m of slack length of wiring (exact length coordinated suiting systems connections), for extending and termination to BAS panel.
 - .4 Identify wiring and junction box.
- .18 Ground and bond system.

3.02 IDENTIFICATION

- .1 Provide product identification.
- .2 Nameplates:
 - .1 Panels: Size 4 engraved, unless otherwise noted.
 - .2 Controllers: Size 2 engraved, unless otherwise noted.
- .3 Provide identification labels at start and end of each heating cable run, every 4.5 m, at bends, branches, risers both sides of wall and floor penetrations and at access doors.
- .4 Review nomenclature with Consultant.

3.03 FIELD QUALITY CONTROL

- .1 Include for manufacturer authorized representative to inspect, start-up, test and verify work as follows:
 - .1 Provide onsite inspection of system installations.
 - .2 Test and verify that automatic control systems, in conjunction with heating cables are functioning in proper operation.
 - .3 Inspect installations verifying compliance with manufacturer instructions and requirements.
 - .4 Test controls and sensors connected in system, for operation in accordance with manufacturer guidelines and Owner directions.
 - .5 Test and verify remote communications.
 - .6 Unless otherwise noted, perform testing as non-destructive.
 - .7 Prepare compliance certificates certifying products are properly installed, tested and adjusted, and in proper operating condition.
- .2 Testing of Self-regulating Heating Cables:
 - .1 After installation and before and after installing thermal insulation, test cable in accordance with requirements of IEEE 515, IEEE 515.1 and applicable system manufacturer instructions.
 - .2 Subject self-regulating heating cables to insulation resistance testing using 2500 VDC Megger, conducted at three voltages: 500, 1000, and 2500 VDC, and at following times:
 - .1 Heating cable received at site before installation.
 - .2 Heating cable after installation, but before insulation is installed.
 - .3 Heating cable after insulation is installed.
 - .4 At final commissioning prior to being energized.
 - .3 Minimum insulation resistance readings: 1000 megohms or greater. Record results.
 - .4 Replace cable with reading less than this value.
 - .5 Record heating-cable circuit capacitance as means for finding fault within section of heating cable and also determining total heating cable length.
- .3 Testing of MI Heating Cables:
 - .1 After installation and before and after installing thermal insulation, test cable in accordance with requirements of IEEE 515, IEEE 515.1 and applicable system manufacturer instructions.

- .2 Subject MI cables to insulation resistance testing, applying 1000 VDC to cables and test cable, verifying readings in excess of 1000 megohms, at following times:
 - .1 Heating cable received at site before installation.
 - .2 Heating cable after installation, but before insulation is installed.
 - .3 Heating cable after insulation is installed.
 - .4 At final commissioning prior to being energized.
- .3 Under applied 1000 VDC, measured megohmmeter readings to minimum acceptable readings in accordance with IEEE 515 or IEEE 515.1. Perform separate field megohmmeter readings of insulation resistance on each cable. Record results.
- .4 Replace cable with readings less than these values.
- .4 Obtain compliance certificates and submit with reports.
- .5 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 CSA Group (CSA):
 - .1 CSA C22.2 No. 46-[13(R2018)], Electric Air-Heaters.
- .2 NSF International (NSF):
 - .1 NSF Protocol 335-[2007], Hygienic Commercial Hand Dryers.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include:
 - .1 Ratings.
 - .2 Controls.
 - .3 Manufacturer standard colour chart of finishes.
 - .4 Mounting installations.
- .3 Submit testing and verification reports.

2. Products

2.01 GENERAL

- .1 Electric Dryers:
 - .1 CSA certified, or ULC listed and labeled.
 - .2 In accordance with CSA C22.2 No. 46.
 - .3 Ratings: As noted.
 - .4 Dimensions: Unless otherwise noted, refer to drawings.

2.02 ELECTRIC HAND DRYERS – STANDARD

- .1 ADA compliant electric hand dryers.
- .2 Features:
 - .1 Surface mounted.
 - .2 Electrical:
 - .1 Rated Power: 2300 W.
 - .2 Motor:
 - .1 Thermally-protected, universal brush-type motor.

- .2 7,500 rpm.
- .3 1/10 HP.
- .3 Heater:
 - .1 2100 watt nichrome wire heating element.
 - .2 Protected by automatic-resetting, thermal cutoff.
- .4 Construction:
 - .1 304 stainless steel cover, brushed or polished finished.
 - .2 Anti-tamper exterior screws.
 - .3 Wall-mounted base: Constructed of die-cast aluminum.
 - .4 Recessed units include minimum 16-gauge steel wall-mounting box.
- .5 Nozzle:
 - .1 Constructed of die-cast zinc alloy finished in bright chrome.
 - .2 Fixed or swivel.
- .6 Operation: Touch-free infrared sensor activation with automatic drying cycle.
- .7 Minimum 5.6 cubic metre per minute of air volume and 2225 linear meters per minute of air velocity.
- .8 Standard warranty: 10 years limited warranty (5 years on sensors).

2.03 ELECTRIC HAND DRYERS – HIGH VELOCITY

- .1 Hi-speed, non-heated hand dryers.
- .2 Features:
 - .1 Hand Dry Time: 12 seconds.
 - .2 Surface mounted.
 - .3 Electrical:
 - .1 Rated Power: 1100 W.
 - .2 Motor:
 - .1 Thermally-protected, universal brush-type motor.
 - .2 32,000 rpm.
 - .3 1.5 HP.
 - .3 Entire mechanism internally grounded.
 - .4 Heater: No heating element, use of ambient temperature drying.
 - .5 Construction:
 - .1 Aluminum cover finished in chrome plating or epoxy paint incorporating antimicrobial additive.
 - .2 Anti-tamper exterior screws.
 - .3 Water ingress protection: IP24.
 - .4 Vandal-resistant and tamperproof.
 - .5 Antimicrobial technology protects treated surfaces by inhibiting growth of bacteria, mold and fungus that can cause stains, odors or deterioration.
 - .6 Nozzle Type: Multi-jet ports for diffused, comfort dry.
 - .7 Minimum 2.97 cubic metre per minute of air volume and 5525 linear meters per minute of air velocity.
 - .8 Sound Level: Maximum 85 dBA, with hands.

- .9 Control: Activated by automatic active infrared sensor controlled by circuit board with 1-second run-on time and 30 second vandal shut-off.
- .10 Mounting backplate and hardware.
- .11 Recessed units include recessed mounting kit.
- .12 Standard warranty:
 - .1 5 years limited (not including replaceable filters).
 - .2 Motor and electronic controls: 3 years.

2.04 ELECTRIC HAND DRYERS WITH HEPA FILTERS

- .1 Hygienic, ADA compliant high air flow electric hand dryers.
- .2 Features:
 - .1 Surface wall-mounting.
 - .2 Electrical:
 - .1 Rated Power: 950 to 1150 W.
 - .2 Motor:
 - .1 Thermally-protected universal type, through-flow discharge vacuum type.
 - .2 Replaceable brushes.
 - .3 5/8 HP.
 - .4 31,000 rpm motor speed.
 - .5 3 speed selector switch.
 - .3 Standby Power Consumption: Less than 0.5 W.
 - .3 Heater: Nichrome wire construction, 475 watts, with auto-reset thermal-protector.
 - .4 Construction:
 - .1 Stainless steel cover, brushed or polished finished.
 - .2 Anti-microbially integrated external plastics and seals.
 - .3 Anti-tamper exterior screws.
 - .4 Water ingress protection: IP24.
 - .5 Hygienic Features:
 - .1 Filtration: Replaceable anti-microbial glass fiber HEPA filter, with bacteria removal from air of 99.9%.
 - .6 Operation:
 - .1 Touch-free infrared sensor activation with 45 second vandal-resistant lock out feature.
 - .2 Hand Dry Time: 12 seconds (adjustable).
 - .3 Airspeed at Nozzle: 240 to 360 km/h.
 - .4 Operating Airflow: Up to 20 to 30 L/s.
 - .5 Rated Operating Noise Power: Maximum 69 dB(A) at 2 m.
 - .7 Standard warranty: 10 years limited warranty (7 years motor and controls) excluding filters and motor brushes.

2.05 HIGH AIR FLOW JET ELECTRIC HAND DRYERS

- .1 Hygienic, high air flow jet type electric hand dryers.
- .2 Features:

- .1 In accordance with NSF P335.
- .2 Surface wall-mounting.
- .3 No heater.
- .4 Electrical:
 - .1 Input Voltage: As noted, 60 Hz.
 - .2 Rated Power: 1000 W.
 - .3 Motor:
 - .1 Brushless DC type digital motor.
 - .2 92,000 rpm motor speed.
 - .4 Standby Power Consumption: Less than 0.5 W.
- .5 Construction:
 - .1 Polycarbonate-ABS casing with anti-microbial resistant lacquer coating.
 - .2 Anti-microbially integrated external plastics and seals.
 - .3 Anti-tamper exterior pin-hex screws.
 - .4 Water ingress protection: IP24.
 - .5 Colour Finish: Sprayed nickel or white, as reviewed with Consultant.
 - .6 ABS/PBT plastic back plate/mounting bracket.
 - .7 Slim format: 100 mm deep, no recessing required.
- .6 Hygienic Features:
 - .1 Filtration: Replaceable anti-microbial glass fiber HEPA filter, with bacteria removal from air of 99.9% of particles, as small as 0.3 microns, including bacteria and viruses.
 - .2 Bacterial reduction rate from external surfaces: Up to 99.9% over 24 hours.
 - .3 Dirty filter replacement indication.
- .7 Operation:
 - .1 Touch-free capacitive sensor activation.
 - .2 Hand Dry Time: 12 seconds.
 - .3 Airspeed at Nozzle: 675 km/h.
 - .4 Operating Airflow: Up to 20 L/s.
 - .5 Rated Operating Noise: Maximum 79 dB(A).
- .8 Standard warranty:
 - .1 5 years parts, 5 years limited labour.

2.06 HIGH AIR FLOW JET ELECTRIC HAND DRYERS

- .1 Energy efficient, high air flow jet type electric hand dryers.
- .2 Features:
 - .1 Switch between two modes, ECO and MAX.
 - .2 Curved blade design.
 - .3 Surface wall-mounting.
 - .4 No heater.
 - .5 Electrical:
 - .1 Input Voltage: As noted, 60 Hz.

- .2 Rated Power: Two power modes: 650 W (ECO mode) to 900 W (MAX mode).
- .3 Motor:
 - .1 Brushless DC type digital motor.
 - .2 75,000 rpm motor speed.
- .4 Standby Power Consumption: Less than 0.5 W.
- .6 Construction:
 - .1 Stainless steel , brushed (304L) fascia.
 - .2 Anti-tamper exterior pin-hex screws.
 - .3 Water ingress protection: IP24.
 - .4 Colour Finish: Stainless steel , brushed (304L).
 - .5 Stainless steel back plate/mounting bracket.
 - .6 Slim format: 100 mm deep, no recessing required.
- .7 Hygienic Features:
 - .1 Filtration: Replaceable anti-microbial glass fiber HEPA filter, with bacteria removal from air of 99.9% of particles, as small as 0.3 microns, including bacteria and viruses.
 - .2 Bacterial reduction rate from external surfaces: Up to 99.9% over 24 hours.
 - .3 Contains antibacterial additive.
 - .4 Dirty filter replacement indication.
- .8 Operation:
 - .1 Touch-free sensor activation.
 - .2 Hand Dry Time: 10 seconds (MAX) mode; 12 seconds (ECO) mode.
 - .3 Airspeed at Nozzle: 624 km/h (MAX mode); 543 km/h (ECO mode).
 - .4 Operation Lock-out Period: 30 seconds.
 - .5 Operating Airflow: Up to 23 L/s.
 - .6 Rated Operating Noise: Maximum 79 dB(A) (MAX mode); Maximum 77 dB(A) (ECO mode).
- .9 Standard warranty:
 - .1 5 years parts, 5 years limited labour.

2.07 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Standard Hand and Hair Dryers:
 - .1 Ouellet.
 - .2 Comac.
 - .3 Nova.
 - .4 World Dryer.
 - .5 American Dryer.
 - .6 Dyson.
- .2 High Air Flow Jet Hand Dryers:
 - .1 Dyson Canada (Airblade).
- .3 Electric Towel Warmer Radiators:

- .1 Equivalent to Runtal.

3. Execution

3.01 INSTALLATION OF ELECTRIC HAND DRYERS

- .1 Provide electrical hand dryers in locations.
- .2 Prior to roughing-in, review locations and mounting heights with Consultant.
- .3 Obtain training from manufacturer representative on special installation procedures. Install products in accordance with manufacturer recommendations and instructions.
- .4 Refer to ratings and sizing of units as noted.
- .5 Prior to ordering, review finishes with Consultant.
- .6 Prior to ordering, review heating unit inlet and outlet configurations with Consultant.
- .7 Install wall mounted electric hand dryers and mount with back plates or onto recessed backboxes.
- .8 Provide hardware and accessories for mounting dryers. Provide mounting provisions suitable in respect for particular construction on which dryers are mounted. Refer to drawing notes.
- .9 Do not exceed manufacturer instructions on limits to circuit loading.
- .10 Connect units to circuits with ground fault circuit interrupting protection in accordance with manufacturer recommendations and electrical codes.
- .11 Ground and bond units.
- .12 Make power connections.

3.02 INSTALLATION OF TOWEL WARMER RADIATORS

- .1 Provide electric towel warmer radiators in locations as noted. Review locations with Consultant prior to roughing-in.
- .2 Obtain training from manufacturer representative on special installation procedures. Install products in accordance with manufacturer instructions suiting specific installation requirements.
- .3 Where noted, install remote thermostat in locations. Mount in recessed wall boxes. Connect complete with required wiring in conduit.
- .4 Review finishes with Consultant prior to ordering.
- .5 After installation is complete, test and adjust as required.
- .6 Comply with applicable requirements with regards to circuiting and grounding/bonding.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing and Verification:
 - .1 Inspect, test, adjust and verify operations of installed heaters and controls.
 - .2 Check connections and operations.
 - .3 Test cut-out protection when air movement is obstructed.
 - .4 Test fan delay switch to assure dissipation of heat after element shut down.

- .5 Test unit cut-off when fan motor overload protection has operated.
- .6 Verify heaters and controls operate correctly.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/Telecommunications Industries Association (ANSI/TIA):
 - .1 ANSI/TIA-569-E-[2019], Telecommunications Pathways and Spaces.
 - .2 ANSI/TIA-606-D-[2021], Administration Standard for Telecommunications Infrastructure.
 - .3 ANSI/TIA-607-E-[2024], Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
 - .4 ANSI/TIA-942-C-[2024], Telecommunications Infrastructure Standard for Data Centers.
- .2 CSA Group (CSA):
 - .1 CSA C22.1-[24], Canadian Electrical Code (CEC), Part 1 ([26th Edition]), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No. 41-[22], Grounding and Bonding Equipment (Tri-national Standard, with NMJ-J-590-ANCE and UL 467).
- .3 Telecommunications Industries Association (TIA):
 - .1 TIA-568 Set-[2023], Commercial Building Telecommunications Cabling Standard Set.
- .4 Telecommunications grounding and bonding system consist of grounding busbars, bonding backbones, and other bonding conductors.
- .5 Provides ground reference for telecommunications systems within building and bonding to it of telecommunications rooms.
- .6 Metallic pathways, cable shields, conductors, and hardware within telecommunications spaces are bonded to telecommunications grounding and bonding system.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include installation details required by AHJ.

2. Products

2.01 GENERAL

- .1 Telecommunications Products:

- .1 CSA certified, or ULC listed and labeled, as grounding and bonding equipment.
- .2 In accordance with ANSI/TIA-607-E and CSA C22.2 No. 41.
- .3 Installations in accordance with TIA-568 Set and ANSI/TIA-569-E.

2.02 GROUND ELECTRODE

- .1 In accordance with CSA C22.1, CSA C22.2 No. 41, and provincial electrical code requirements.
- .2 Grounding and Bonding Conductors:
 - .1 Insulated: Green insulated, copper conductors.
 - .2 Bare: Stranded copper, soft annealed.
 - .3 Size as noted, or where not sized, size in accordance with requirements of electrical codes.
- .3 Rod Electrodes: Copper clad steel, 19 mm diameter by not less than 3 m long.
- .4 Grounding Clamps: Copper, corrosion-resistant, of type suiting intended applications.
- .5 Additional requirements: Refer to Section 26 05 26 - Grounding and Bonding.

2.03 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- .1 Predrilled busbar constructed of solid copper, electro-tin plated, with standard NEMA bolt hole sizing and spacing for type of connectors. (Both holes in two holed lugs are attached to busbar). Provide with:
 - .1 30 attachment points (two rows of 15 each) for two-hole grounding lugs.
 - .2 Accepting 27 lugs with 15.8 mm hole centers and 3 lugs with 25.4 mm hole centers.
 - .3 Dimensions: Minimum 6 mm thick, 100 mm wide, 500 mm long, unless otherwise noted.
 - .4 Wall-Mounting: Using stand-off brackets, assembly screws and insulators creating 100 mm standoff from wall.
- .2 Prior to ordering, review arrangements with Consultant and Division 27 telecommunications system vendor.

2.04 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

- .1 Predrilled busbar constructed of solid copper, electro-tin plated, with standard NEMA bolt hole sizing and spacing for type of connectors used. (Both holes in two holed lugs attached to busbar). Provide with:
 - .1 9 attachment points (one row) for two-hole grounding lugs.
 - .2 Accepting 6 lugs with 15.8 mm hole centers and 3 lugs with 25.4 mm hole centers.
 - .3 Dimensions: Minimum 6 mm thick, 50 mm wide, 300 mm long, or as indicated on drawings.
 - .4 Wall-Mounting: Using stand-off brackets, assembly screws and insulators creating minimum 50 mm standoff from wall.
- .2 Prior to ordering, review arrangements with Consultant and Division 27 telecommunications system vendor.

2.05 BONDING CONDUCTOR FOR TELECOMMUNICATIONS

- .1 Minimum No. 6 AWG unless otherwise noted, copper conductor, green insulated.
- .2 Minimum same size as telecommunications bonding backbone.

2.06 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- .1 Minimum 3/0 AWG, unless otherwise noted, copper conductor, green insulated.
- .2 In accordance with sizing requirements of ANSI/TIA-607-E.

2.07 GROUND/BONDING TERMINAL BLOCK

- .1 Constructed of electroplated tin aluminum extrusion.
- .2 Accepts conductors ranging from #14 AWG through 2/0 AWG.
- .3 Conductors held in place with two stainless steel set screws.
- .4 Unless otherwise noted, two 6.4 mm holes spaced on 15.8 mm centers allowing secure two-bolt attachment to rack or cabinet.

2.08 COMPRESSION LUGS

- .1 Manufactured from electroplated tinned copper.
- .2 Unless otherwise noted, two holes spaced on 15.8 mm or 25.4 mm centers, allowing secure two bolt connections to busbars.
- .3 Sized fitting specific size conductor, sizes #6 AWG to 4/0 AWG.

2.09 C-TYPE, COMPRESSION TAPS

- .1 Manufactured from copper alloy.
- .2 C-shaped connectors wrapping around two conductors forming irreversible splice around conductors with installation requiring hydraulic crimping tool.
- .3 Sized fitting specific size conductors, sizes #2 AWG to 4/0 AWG.

2.10 PEDESTAL CLAMP WITH GROUNDING CONNECTOR

- .1 Constructed from electroplated tinned copper or bronze. Installation hardware of stainless steel.
- .2 Sized fitting specific size conductor, size #6 AWG or 2/0 AWG.
- .3 Sized attaching to round, or square raised access floor pedestals 25 mm to 45 mm in diameter.
- .4 Provides straight (in-line) or cross (intersection) support for up to two conductors.

2.11 PIPE CLAMP WITH GROUNDING CONNECTOR

- .1 Constructed from electroplated tinned bronze. Installation hardware of stainless steel.
- .2 Sized fitting up to two conductors ranging in size from #6 AWG to 250 MCM. Conductors are of same size.
- .3 Sized attaching to pipes, sizes 25 mm to 150 mm in diameter.

2.12 EQUIPMENT GROUND JUMPER KIT

- .1 One 600 mm long insulated ground jumper with straight two-hole compression lug on one end and L-shaped two-hole compression lug on other end.

- .2 Two plated installation screws, abrasive pad and tube of antioxidant joint compound.
- .3 Ground Conductor: Insulated green/yellow stripe #6 AWG wire.
- .4 Lugs: Electroplated tinned copper, with two mounting holes suiting intended applications.

2.13 H-TAPS

- .1 For permanent pig-tailing, two-way splicing, for making copper tap and parallel connections, and provides tapping to unbroken continuous main.
- .2 Manufactured of wrought copper, electro-tin plated preventing corrosion and oxidation.
- .3 Colour-keyed or marked with colour matching correct installation die.

2.14 MISCELLANEOUS

- .1 Rack Grounding Strip:
 - .1 Full height of rack, 17 mm wide, 1.25 mm thick, EIA universal mounting hole pattern and constructed of high conductivity, low resistance wrought copper and tin plated.
 - .2 With antioxidant joint compound and thread-forming screws.
 - .3 One rack grounding strip provided for every two-post rack and mounted to rear of side rail of each rack.
- .2 Cabinet Grounding Strip Kit:
 - .1 Grounding strips of length suiting cabinet quantity of rack units, 17 mm width, 1.27 mm thick.
 - .2 EIA Universal mounting hole pattern and constructed of high conductivity, low resistance wrought copper and tin plated.
 - .3 4 grounding strips, antioxidant joint compound and bonding studs.
 - .4 One kit provided for every cabinet and grounding strips mounted to each cabinet equipment rail.
- .3 Grounding Busbar Kit:
 - .1 Bus bar, 480 mm long, made of high conductivity, low resistance wrought copper and tin plated.
 - .2 Unless otherwise noted, twenty holes arranged for flexibility in mounting with twenty #12-24 x 12 mm hex head screws installed, mounting hole sets have 15.9 mm spacing, provided with thread-forming screws, and flat washers for mounting.
 - .3 One kit provided for every cabinet.
- .4 Grounding Clamps:
 - .1 Mechanical Grounding Connector:
 - .1 Above ground or within inspection pits.
 - .2 Connecting cable to rod or pipe, or other types suiting intended applications.
 - .3 High copper alloy.
 - .4 U-Bolts, nuts and lock-washers of bronze construction.
 - .5 Corrosion-resistant.
 - .2 Thermite welding process consisting of manufacturer packaged materials providing welding connections.

- .5 Antioxidant Joint Compound:
 - .1 Use when making bonding connections.
 - .2 Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.
- .6 Bonding Screws:
 - .1 Bonding screws with serrations on bottom of screw to remove paint from patch panel to bond patch panel to rack or cabinet rails.
 - .2 Bonding screws thread-forming to remove paint from threaded rack or cabinet rail holes to bond patch panel to rack or cabinet rails.
 - .3 Provide sufficient screws for mounting each patch panel.
- .7 Paint Piercing Washers:
 - .1 Paint piercing washer kits with antioxidant joint compound.
 - .2 Installed where rack elements bolt together.
 - .3 Installed where vertical cable managers are manufactured of metal.
 - .4 Installed for every nut/bolt set.
- .8 Warning Labels and Identification:
 - .1 In accordance with ANSI/TIA-606-D.
 - .2 Non-metallic warning labels with nomenclature as reviewed with Consultant.

3. Execution

3.01 INSTALLATION

- .1 Perform outdoor and underground grounding and bonding connections using exothermic welding.
- .2 Install TMGB in entrance room and other areas as reviewed with Consultant, and as noted. Wall-mount on insulated supports 100 mm high at location close to electrical power panel where one is installed in same room, and as indicated.
- .3 Prior to roughing-in work, review installation locations with Consultant.
- .4 Install bonding conductor in conduit for telecommunications from TMGB to main service equipment (power) ground. Label conduit identifying use, as reviewed with Consultant.
- .5 Perform surface grounding and bonding connections to TMGB in climate-controlled areas using 2-hole compression lugs.
- .6 For cables within telecommunications entrance room having shield or metallic member: Bond shield or metallic member to TMGB with green insulated copper conductor.
- .7 Install TGB in main terminal or equipment room and each telecommunications room. Wall-mount on insulated supports 100 mm high in locations as reviewed with Consultant.
- .8 Make conductor connections to TMGB and TGB with two-hole bolt-on compression lugs sized fitting busbar and conductors.
- .9 Attach each lug with stainless steel hardware after preparing bond in accordance with manufacturer recommendations and treating bonding surface on busbar with antioxidant.
- .10 Install TBB and connect directly to TMGB, TGB and to components. Size TBB in accordance with ANSI/TIA-607-E.

- .11 Install rack-mount horizontal or vertical busbar or ground bar or ground terminal block to racks and cabinets, in accordance with manufacturer instructions. Bond rack-mount busbar or ground bar or terminal block to room TMGB or TGB with hardware and conductors.
- .12 Provide bonding pedestal clamp at minimum, every fourth raised access floor pedestal with minimum #6 AWG conductor extending to TMGB or TGB. Increase number of clamps and sizing of conductors in accordance with requirements of electrical code.
- .13 Bond metal pipes located inside computer rooms with minimum #6 AWG conductor to TMGB or TGB, using pipe clamp sized fitting pipe and conductor and installed in accordance with manufacturer recommendations. Increase conductor size in accordance with requirements of electrical code.
- .14 At connections and attachment points of grounding and bonding components to equipment, remove paint, clean surfaces and apply antioxidant compound.
- .15 Where routing grounding conductors through metal conduit is unavoidable, bond each end of conduit to grounding conductors.
- .16 Bond equipment and racks in accordance with ANSI/TIA-942-C. Provide paint piercing grounding washers where rack sections bolt together, on both sides, under head of bolt and between nut and rack.
- .17 Install full-length rack ground strips, attached to rear of side rail with thread-forming screws.
- .18 When equipment manufacturer provides location for mounting grounding connection, utilize that connection.
- .19 Bond patch panels to racks using bonding screws.
- .20 Make buried connections using copper welding by thermite process using manufacturer packaged materials in accordance with manufacturer instructions.

3.02 IDENTIFICATION

- .1 Provide product identification.
- .2 Equipment Main Nameplates: Size 4 unless otherwise noted.
- .3 Identify each box for intended service and location of opposite end of conduit pathway.
- .4 Apply identification and warning labels to telecommunications bonding and grounding conductors, in accordance with requirements of specified telecommunications systems standards and requirements specified in Division 27.
- .5 Label conduit identifying use, as reviewed with Consultant.

3.03 FIELD QUALITY CONTROL

- .1 Inspection, Testing and Verification:
 - .1 Inspect, test and verify products.
 - .2 Visually inspect grounds and bonds for loose connections.
 - .3 Test potential difference between TMGB and electrical ground and between TMGB and each TGB.
 - .4 Install connection at TMGB from main electrical service ground in accordance with local governing electrical code and TIA requirements.

- .5 Test system for stray currents, ground shorts, similar issues. Where faulty conditions are detected, eliminate and correct.
 - .6 Ground resistance typically not to exceed 2 ohms, as reviewed with Consultant.
 - .7 Perform ohm resistance testing between TGB and racks, cable tray, and electronic equipment, to identify high resistance connections.
 - .8 Difference in ground potential between telecommunications and electrical system at workstation, typically not to exceed 1.0 volt, as reviewed with Consultant.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/Telecommunications Industries Association (ANSI/TIA):
 - .1 ANSI/TIA-607-E-[2024], Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
 - .2 ANSI/TIA-568 Set-[2023], TIA Commercial Building Telecommunications Cabling Standard Set, including:
- .2 CSA Group (CSA):
 - .1 CSA C22.1-[24], Canadian Electrical Code (CEC), Part 1 ([26th Edition]), Safety Standard for Electrical Installations.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit pathways rough-in drawings coordinated and signed off by respective communications system vendors identifying routing of pathways, sizes of boxes and other requirements accommodate installation of system cabling and equipment.

1.03 DESCRIPTION OF SYSTEM

- .1 Provide system of backboards, empty conduits, cable trays, outlet backboxes and pull boxes, accommodating installation of structured cabling system components and wiring, to serve multiple systems and equipment.
- .2 Structured cabling system is specified in another Division 27 Section.
- .3 Telecommunication requirements are based on Category [6] UTP system and Owner Standards. Prior to start of work, review guidelines and requirements with Consultant.

2. Products

2.01 BACKBOARDS

- .1 G1S (good one side) construction grade fir plywood.
- .2 Containing no urea formaldehyde.
- .3 Painted finished fire rated plywood, or plywood entirely covered with two coats of flame-retardant prime coat paint. Flame spread rating in accordance with building code requirements.
- .4 Minimum 1219 mm wide x 2438 mm long x 20 mm thick, unless otherwise noted.

- .5 Openings for access to and use of electrical outlets and other equipment on walls.

2.02 CONDUITS

- .1 In accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings.
- .2 Climate Controlled Areas: EMT type, with press fit insulating nylon bushings at conduit ends and stubs, and insulating nylon, set screw fitting at boxes.
- .3 Exterior or other non-climate-controlled areas: PVC where permitted by electrical code, or rigid galvanized steel.
- .4 Sizing and number of runs as noted.
- .5 Main conduit pathways extending from Entrance Facilities (EF) to Central Equipment Rooms (CER) and from CER out to Telecom Rooms (TR): Minimum 100 mm diameter, unless otherwise noted.
- .6 Minimum Size: 27 mm EMT conduit. Provide increased sizing, suiting wiring filling requirements of electrical code, and system manufacturer requirements.
- .7 Bushings: Sized suiting conduit sizing.

2.03 CABLE TRAYS

- .1 Sized as noted.
- .2 Black Powder Coated Finish Basket Type: In accordance with Section 26 05 36 - Cable Trays and Wireways.

2.04 OUTLET BOXES AND BACK BOXES

- .1 General Boxes: In accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Wall Outlet Boxes and Back Boxes: Galvanized steel, flush mounted, with plaster rings. Sized for intended devices.

2.05 PULL BOXES

- .1 General Boxes: In accordance with Section 26 05 31 - Splitters and Electrical Boxes.
- .2 Sizing: Not less than as indicated in Table 1 and Table 2.
- .3 Galvanized steel with hinged lockable cover.
- .4 Pull Cords: Polypropylene, 180 kg pull strength, in empty conduit runs.

2.06 MISCELLANEOUS

- .1 Cover Plates for Wall Outlet boxes and Backboxes: Suiting size of boxes. Review finishes with Consultant. Refer to requirements of respective box trade Sections.
- .2 Sleeves: In accordance with Section 26 05 00 - Common Work Results for Electrical.
- .3 Cable Bending Radii Provisions: Provide increased size of boxes to accommodate cable bending radii of category rating of UTP structured cabling system, in accordance with ANSI/TIA-568 Set of Telecommunications Standards. For additional requirements, refer to another Division 27 Section.
- .4 Acoustical Putty Pads: UL listed, 3.5 mm thick, non-hardening and permanently resilient.

3. Execution

3.01 INSTALLATION - GENERAL

- .1 Coordinate and verify pathways standards and requirements with communications system vendors responsible for providing equipment. Refer to drawing details for additional requirements.
- .2 Comply with applicable installation requirements of ANSI/TIA-568 Set of Telecommunications Standards.
- .3 Install empty conduit system, conduit nylon bushings, fish wires, plywood backboards, outlet boxes, pull boxes, sleeves, caps and miscellaneous accessories, accommodating installation of telecommunications systems. Refer to drawings for additional installation requirements.
- .4 Stub conduits 50 mm into Telecom rooms. Do not extend ceiling conduits more than 76 mm into Telecom or equipment rooms.
- .5 Mount outlet boxes as reviewed with Consultant, as follows:
 - .1 Flush-mounted in walls of finished areas.
 - .2 Flush-mounted in ceilings.
 - .3 Flush-mounted in counters.
 - .4 Surface-mounted where connecting conduit is exposed in unfinished areas.
 - .5 Coordinating with systems equipment requirements.
- .6 Provide power boxes and outlets coordinated for system equipment.
- .7 Ground and bond in accordance with ANSI/TIA-607-E and Section 27 05 26 - Grounding and Bonding for Communications Systems.
- .8 Provide sleeves in locations as noted, typically between rooms. Provide sleeves of minimum 100 mm diameter, unless otherwise noted. Equip sleeves with plastic bushings. Extend sleeves to protrude not more than 75 mm above finished floor.
- .9 Seal penetrations through fire-rated construction with firestopping and smoke seal-materials in accordance with requirements of Division 07.
- .10 Coordinate requirements with telecommunication systems vendors, and review with Consultant.
- .11 Refer to drawings for additional installation requirements and specific sizing requirements.

3.02 INSTALLATION OF BACKBOARDS

- .1 Provide backboards in locations, mounted from 150 mm above finished floor and extending length of backboard.
- .2 Wall mount each backboard with fasteners suiting wall construction.
- .3 Install nails or screws, rising above surface of plywood.

3.03 INSTALLATION OF CONDUITS AND BOXES

- .1 Unless otherwise noted, install 127 mm x 127 mm x 73 mm deep square electrical steel box for wall-mounted outlets, LAN applications and for Wi-Fi locations. Include double gang plaster ring with boxes. Extend from wall-mounted boxes, minimum 27 mm diameter conduit in wall up to and stubbing into accessible ceiling space, unless otherwise noted.
- .2 Provide cover plates for each box.
- .3 Where data outlets are located adjacent to light switches, maintain minimum 200 mm separation.
- .4 Run exposed conduits as high as possible, but accessible from workable height.
- .5 Make vertical transitions with gradual slope accommodating cable bending radii requirements.
- .6 For 2 contiguous 3 m sections of conduit, provide supports at minimum 3 points along length of conduits.
- .7 Terminate conduits with end connectors and plastic bushings.
- .8 Provide pull cords in empty conduit runs.
- .9 Make 90-degree transitions as sweeping bends accommodating cable bending radii requirements.
- .10 Bending radii for conduit less than 53 mm diameter: 6 times inner diameter of conduit.
- .11 Bending radii for conduit 53 mm diameter and greater: 10 times inner diameter of conduit.
- .12 Conduit runs exceeding 30 m in length, or with more than two - 90° bends: Equip with pull box installed at intermediate accessible location facilitating conductor installations.
- .13 Do not use double-gang electrical boxes as pull boxes.
- .14 Do not use pull boxes in lieu of a bend. Align conduits opposite each other within pull box. Refer to Figure 1, at end of Section.
- .15 Size pull boxes in accordance with Table 1 and Table 2, at end of Section.
- .16 Refer to Section 26 05 31 - Splitters and Electrical Boxes for additional pull box installation requirements.

3.04 INSTALLATION OF CABLE TRAYS

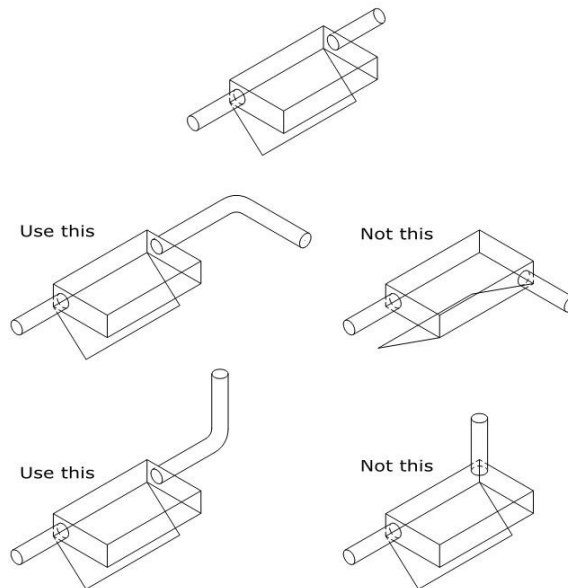
- .1 Provide basket type cable trays in areas as noted, to collect communication cabling from wall devices and floor boxes. Terminate cable trays at system racks in associated designated rooms.
- .2 Refer to Section 26 05 36 - Cable Trays and Wireways, for installation requirements.

3.05 IDENTIFICATION

- .1 Provide product identification.
- .2 Equipment Main Nameplates: Size 4 unless otherwise noted.
- .3 Identify each box for intended service and location of opposite end of conduit pathway.
- .4 Identify conductors.

3.06 FIGURES AND TABLES

- .1 Figure 1 - Appropriate Pull Box Configuration:



.2 Choosing Pull Box (PB) Size:

.1 Minimum space requirements in pull boxes having one conduit each in opposite ends of box:

.1 Table 1 - Appropriate Pull Box Sizes for Outside Plant Cable:

Conduit Trade Size (mm)	Width (mm)	Length (mm)	Depth (mm)	Width Increase for Each Additional Conduit (mm)
27	102	406	76	51
35	152	508	76	76
41	203	686	102	102
53	203	914	102	127
63	254	1067	127	152
78	305	1219	127	152
91	305	1372	152	152
103	381	1524	203	203

.2 Table 2 - Appropriate Pull Box Sizes for Inside Horizontal Cabling:

Conduit Trade Size (mm)	Width (mm)	Length (mm)	Depth (mm)	Width Increase for Each Additional Conduit (mm)
27	102	305	76	51
35	152	406	76	76
41	152	406	102	102
53	203	610	102	127
63	254	610	127	152
78	254	762	127	152
91	305	762	152	152
103	408	914	203	203

END OF SECTION

1. General

1.01 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include: Electrical schematic, device mounting requirements and rough-in for recessed devices.
 - .3 Finishes: For each finish product supply samples of minimum size 150 mm square representing actual product colour and patterns.
- .3 Submit testing and verification reports.

2. Products

2.01 RESTROOM CALL SYSTEMS

- .1 Performance:
 - .1 System Standards:
 - .1 CSA certified or ULC listed and labeled devices.
 - .2 Requirements of provincial building code.
 - .2 Operations:
 - .1 Activated call station in restroom sends signal to audible and visual devices that indicates that someone in washroom needs assistance.
 - .2 Washroom occupant call receive visual and audible confirmation that their request has been made.
 - .3 Audible devices and visual devices located over washroom door illuminates and sound tone when remote stations are activated. Notification to building staff and occupants outside restroom of emergency condition.
 - .4 Visual and audible signals to be distinct and of different type of signals from other building systems. Audible device sound levels to be user adjustable.
 - .5 Call stations, audible devices and visual devices to only be reset when call has been responded to and activated station locally reset.
 - .6 Sequence of operation verified with Owner and reviewed with Consultant.
- .2 System Components:
 - .1 Pushbutton Stations:
 - .1 Flush-mount.

- .2 Double gang, stainless steel faceplate with 'PRESS FOR EMERGENCY ASSISTANCE' lettering.
- .3 Red 40 mm mushroom push button (push to activate – pull to deactivate and reset).
- .4 LED "Assistance Requested" annunciator with adjustable tamper-resistant sounder.
- .5 N/O and N/C contacts and maintained suiting intended applications.
- .6 [Camden CM-AF540SO series].
- .2 Dome Lights:
 - .1 Single gang LED dome light with 'ASSISTANCE REQUIRED' identification lettering.
 - .2 Integral 93 dB adjustable tamper-resistant sounder.
 - .3 Impact resistant polycarbonate lens.
 - .4 Weather resistant with gasketing.
 - .5 [Camden CM-AF141SO series]
- .3 Instruction Signs:
 - .1 Solid, white, fire-rated PVC, 150 mm x 270 mm, engraved lamacoid emergency signs.
 - .2 Contain wording – "IN EVENT OF EMERGENCY PUSH EMERGENCY BUTTON AND AUDIBLE AND VISUAL SIGNAL WILL ACTIVATE" in letters at least 25 mm high with 5 mm stroke and that is posted above call station.
 - .3 Exact sizing and nomenclature to building code requirements and reviewed with Consultant prior to ordering.
 - .4 [Camden CM-SE21A series].
- .4 Auxiliary Contacts:
 - .1 For remote connection to central monitoring station or connection to other building system to allow for annunciation of calls.
 - .2 Activated automatically when emergency assistance call pushbutton pressed and automatically reset when call pushbutton is reset.
- .5 Miscellaneous:
 - .1 12/24V linear power supplies and 40 VA transformers in accordance with system manufacturer requirements.
 - .2 Wiring, mounting hardware and ancillary devices as recommended by system manufacturer for complete system.
 - .3 Provide weather-resistant and corrosion-resistant devices for devices located in non-climate-controlled areas.
 - .4 Review LED and lens colours with Consultant prior to ordering.

2.02 RESTROOM DOOR CONTROL SYSTEMS

- .1 Performance:
 - .1 System Standards:
 - .1 CSA certified or ULC listed and labeled devices.
 - .2 Requirements of provincial building code and fire codes.
 - .2 Operations

- .1 Electrically operated door normally closed and either locked or unlocked.
 - .2 Waving hand in front of exterior hands-free open switch opens door. LED light ring changes from green (unoccupied) to red (occupied).
 - .3 Once inside and door is closed, waving hand in front of lock switch, changes colour to red and locks door.
 - .4 To exit, wave hand in front of interior open switch to unlock door and reset system. Switch illuminated outer ring turns green and exterior ' open switch illuminated outer ring turns green.
 - .5 If door is opened manually to exit restroom, overhead magnetic contact switch resets system.
 - .6 Status: Normally locked. Fail secure electric strike.
 - .7 Status: Normally unlocked. Fail safe electric strike.
- .2 System Components:
- .1 Advanced logic control relay and 2 Ampere power supply in pre-wired metal cabinet. [Camden CX-33PS].
 - .2 Hands-Free Open Switch Stations (exterior of room):
 - .1 Flush mount, single gang.
 - .2 114 mm activation wall switch of stainless steel construction.
 - .3 'Wave to Open' permanently laser etched graphics.
 - .4 LED light ring, Green/Red, with selectable 12/2 4V, AC/DC, built-in 85 db sounder, maximum 60 mA current draw.
 - .5 Form C contacts rated 3 Amp @ 30 VDC.
 - .6 Sign with 'OCCUPIED WHEN RED' and 'VACANT WHEN GREEN' lettering.
 - .7 [Camden CM-331/42WS-SGLR].
 - .3 Hands-Free Lock Switch Stations:
 - .1 Flush mount, single gang.
 - .2 70 mm x 114 mm activation wall switch of stainless steel construction.
 - .3 'Wave to Lock' permanently laser etched graphics.
 - .4 LED light ring, Green/Red, with selectable 12/24 V, AC/DC, built-in 85 db sounder, maximum 60 mA current draw.
 - .5 N/O contacts rated 3 Amp @ 30 VDC.
 - .6 Double sided sign with 'LOCKED WHEN RED'.
 - .7 [Camden CM-331/43S-SGLR].
 - .4 Hands-Free Open Switch Stations (interior of room):
 - .1 Flush mount, double gang.
 - .2 114 mm activation wall switch of stainless steel construction.
 - .3 'Wave to Open' permanently laser etched graphics.
 - .4 Selectable 12/24V, AC/DC, built-in 85db sounder, maximum 60mA current draw.
 - .5 Form C contacts rated 5 Amp @ 30 VDC.
 - .6 [Camden CM-325/42WS].
 - .5 Surface mount door contacts suiting intended applications and doors.
 - .6 Electric Strikes:
 - .1 Grade 2 universal strike for cylindrical locksets and three faceplates.

- .2 12/24V AC/DC, selectable fail safe/fail secure.
- .3 Horizontal faceplate adjustment.
- .4 Suiting intended applications and doors.
- .7 Door Operators: Refer to and coordinate with Division 08.

2.03 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Call Systems:
 - .1 Camden Door Controls.
 - .2 Aiphone.
 - .3 TOA.
 - .4 Telecor.
 - .5 Rauland.
 - .6 Mircom.
 - .7 Jeron.
- .2 Door Controls:
 - .1 Camden Door Controls.
 - .2 Rutherford Controls.

3. Execution

3.01 INSTALLATION OF RESTROOM CALL SYSTEMS

- .1 Provide call systems components and connect complete. Program sequence of operation confirmed with Owner and reviewed with Consultant. Obtain AHJ approvals as required.
- .2 Obtain training from manufacturer representative on any special installation procedures.
- .3 Install devices in locations as reviewed with Consultant prior to roughing-in. Install components at mounting heights as noted and reviewed with Consultant. Unless otherwise noted, mount devices on recessed back boxes. Locate dome lights above doorframes. Locate power supplies in service room accessible location reviewed with Consultant. Provide power wiring to devices.
- .4 Set sound level of interior audible devices at level required by AHJ, acceptable to Owner and reviewed with Consultant. Adjust as required.
- .5 Provide system wiring of colour coded copper conductors, installed in accordance with system manufacturer recommendations and instructions. Connect equipment in accordance with system manufacturer certified wiring diagrams and instructions and under direct supervision of manufacturer. Run conductors in conduit.
- .6 Install instruction signage in position and secure to wall with mechanical fasteners. Review exact nomenclature, sizing and locations with Consultant prior to ordering.
- .7 Where signage is supplied by others, coordinate installation of signage with General Contractor.
- .8 Where applicable, extend wiring in conduit from system auxiliary contacts to remote monitoring station to allow for annunciation of call at station.
- .9 After installation is complete, test, adjust and verify operation of system. Demonstrate system operation and maintenance with Owner staff.

- .10 Obtain approvals as required from AHJ. Submit copies to Consultant.

3.02 INSTALLATION OF RESTROOM DOOR CONTROL SYSTEM

- .1 Provide door control system components and connect complete. Program sequence of operation confirmed with Owner and reviewed with Consultant. Obtain AHJ approvals as required.
- .2 Obtain training from manufacturer representative on any special installation procedures.
- .3 Install devices in locations as reviewed with Consultant prior to roughing-in. Install components at mounting heights as noted and reviewed with Consultant. Unless otherwise noted, mount devices on recessed back boxes. Provide power wiring to devices.
- .4 Set sound level of interior audible devices at level required by AHJ, acceptable to Owner and reviewed with Consultant. Adjust as required.
- .5 Provide system wiring of colour coded copper conductors, installed in accordance with system manufacturer recommendations and instructions. Connect equipment in accordance with system manufacturer certified wiring diagrams and instructions and under direct supervision of manufacturer. Run conductors in conduit.
- .6 After installation is complete, test, adjust and verify operation of system. Demonstrate system operation and maintenance with Owner staff.
- .7 Obtain approvals as required from AHJ. Submit copies to Consultant.

3.03 IDENTIFICATION

- .1 Provide lamacoid identification nameplate for each enclosure. Confirm wording of identification nameplates and colour finishes of devices with Owner and review with Consultant prior to ordering.

3.04 FIELD QUALITY CONTROL

- .1 Inspection, Start-up, Testing, Commissioning and Verification:
 - .1 Perform inspection and start-up procedures, and programming as recommended by manufacturer. Confirm installation checklist items are completed.
 - .2 When installation is complete start-up each system, set and adjust controls and safeties, check operating controls and integrated systems.
 - .3 Adjust systems in accordance with requirements of AHJ and user defined system performance measures.
 - .4 Inspect, set, test and verify control and monitoring control panels.
 - .5 Inspect and test integrated components.
- .2 Arrange for manufacturer technician to inspect installations and issue compliance certificates to include with reports.
- .3 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA):
 - .1 CAN/ULC-S301-[Edition 3, 2018], Standard for Signal Receiving Centres Configurations and Operations.
 - .2 CAN/ULC-S561-[Edition 3, 2020-REV1], Standard for Installation and Services for Fire Receiving Centres and Systems.
 - .3 ULC 60839-11-1-[Edition 1, 2019-REV2], Alarm and Electronic Security Systems - Part 11-1: Electronic Access Control Systems - System and Components Requirements.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
 - .2 Include:
 - .1 Connection wiring schematic drawings, block system diagrams and sequence of operations.
 - .2 Samples of computer graphic displays, as applicable.
 - .3 Door functionality and schedule of operation of each secured door.
 - .4 Recommended installation and set-up procedures.
 - .5 List of recommended spare parts.
- .3 Submit copies of ULC listing certificates of installing security contractor.
- .4 Submit testing and verification reports.
- .5 Upon completion of Work, submit copies of software, software licenses and software manuals.
- .6 Submit testing and verification reports.

1.03 QUALITY ASSURANCE

- .1 System installation, testing and verification provided by ULC listed Security Contractor companies also designated as System Venders.
- .2 System covered by active and unexpired ULC certificate.
- .3 System Vender Qualifications:
 - .1 Established security systems contractors currently maintaining locally run and operated business for at least five years.
 - .2 Hold applicable provincial and local licenses.

- .3 Regional Canadian Authorized Distributor for products and system proposed, with full manufacturer warranty privileges.
- .4 Employ technicians trained and certified by product manufacturer of proposed system.
- .5 Maintain fully equipped service organization capable of performing inspection and service to system on 24-hour/7-day basis. Maintain at facility, spare parts in proper proportion as recommended by manufacturer to maintain and service proposed supplied system.

2. Products

2.01 GENERAL

- .1 Provide systems in accordance with applicable requirements of:
 - .1 CAN/ULC-S301.
 - .2 CAN/ULC-S561.
 - .3 ULC 60839-11-1.
- .2 Security Contractor responsibilities include but are not limited to following:
 - .1 Providing system components and wiring, except otherwise noted.
 - .2 Performing system component and wiring terminations.
 - .3 Programming and start-up of system.
 - .4 Supplying system licenses, software and manuals.
 - .5 Performing system testing, inspection, commissioning and verification work upon completion of installation work.
 - .6 Preparing testing and verification reports, signed by manufacturer authorized technician.
 - .7 Provision of technical assistance to Division 26 Electrical Contractor with regards to conduit, box and wiring infrastructure installation requirements.
 - .8 Demonstration of installed system.
 - .9 Providing end user training and instructions.
- .3 Electrical Contractor responsibilities include but are not limited to following:
 - .1 Co-ordination of system work with Security Contractor, confirming responsibilities and requirements.
 - .2 Provision of system conduits and boxes, and power feeders, suiting system requirements, in accordance with Division 26 and system manufacturer requirements.
 - .3 Installing Security Contractor supplied system wiring in conduit, as coordinated with Security Contractor.
 - .4 Identification and labelling of each wiring run and components.
 - .5 Installing Security Contractor supplied system components, as coordinated with Security Contractor.
 - .6 Assisting Security Contractor with their work.
 - .7 Obtaining copies of testing and verification reports, reviewing reports, signing reports, and submitting to Consultant.
 - .8 Preparing as-built documentation, as coordinated with Security Contractor.

2.02 MISCELLANEOUS

- .1 All-inclusive parts and labour warranty, with no deductible charges.
- .2 Onsite operating and maintenance instructions to Owner designated personnel.

3. Execution

3.01 INSTALLATION OF ACCESS CONTROL SYSTEM

- .1 Provide components for system. Locate control unit, remote keypads, graphic display, and devices in locations. Connect panels with power wiring.
- .2 Locate panels, expansion nodes, modules and other control devices in accessible locations of service rooms reviewed with Consultant. Do not locate in ceiling spaces.
- .3 Coordinate system requirements with integrated systems and work of other trades.
- .4 Program system to accommodate connected devices and zones, plus specified spare capacity. Confirm zoning and sequence of operation of system with Owner prior to start of Work and review with Consultant.
- .5 Provide keypads complete with protective cover, flush in wall locations with backboxes.
- .6 Install card readers, flush wall-mounted in finished areas. Where installed in non-climate controlled areas, include weather-proof types.
- .7 Coordinate connections to electric strikes, electromagnetic locks, door position switches, door contacts and door operators with door hardware vender and General Trades Contractor. Provide wiring in conduit and run between door hardware components and panel. Terminate wiring and make connections.
- .8 Provide door alarm contacts in doors/frames as detailed and as coordinated with General Contractor and Consultant. Coordinate installation with trade providing doors/frames such that frames are supplied with integral boxes for mounting of flush contacts and type of contacts match door construction. Install two contacts on double doors. Except for double door contacts, each door contact annunciated as distinct zones.
- .9 Mount request-to-exit detectors above exit doors. Secure base plate of each detector to flush backbox and connect with wiring. Adjust each detector to suit specific coverage areas and in accordance with manufacturer recommendations.
- .10 Provide alarm horns and mount in locations and connect complete. Flush mount in finished areas.
- .11 Prior to roughing-in, review locations with Consultant.
- .12 Provide system wiring in conduit from system control panel to telephone equipment backboard for system monitoring via ULC Listed Central Monitoring Station. Connect complete. Perform connections to central monitoring station, in accordance with CAN/ULC-S561.
- .13 Provide system wiring in conduit from fire alarm panel to system control panel for connection of fire alarm and trouble outputs. Coordinate work with fire alarm system vender.
- .14 Provide system wiring in conduit from BAS panel to system control panel for connection of trouble outputs. Coordinate work with BAS system vender.
- .15 Ground and bond system.

- .16 Ground cable shield wiring on panelboard side of wiring run, not at device.

3.02 FIELD WIRING

- .1 Wire each device as distinct zone with end of line resistors.
- .2 Do not wire devices as combination zones except for multiple-door entrances.
- .3 Wire door contacts as one zone, except for contacts on double doors.
- .4 Wire devices as separate runs and not daisy chained.
- .5 Run wiring in rigid conduits, or where noted in cable tray or surface raceways.
- .6 Do not run wiring exposed.
- .7 Do not install wiring to underside of steel decks.
- .8 Surface mounted electrical boxes for devices in mechanical rooms and similar service rooms: FS style boxes with no knockouts.
- .9 Run wiring into cabinets as side or bottom conduit entry.
- .10 Run wiring into main panels in electrical splitter troughs, not as loose wiring.
- .11 Provide wiring in accordance with system manufacturer recommendations.

3.03 IDENTIFICATION LABELLING

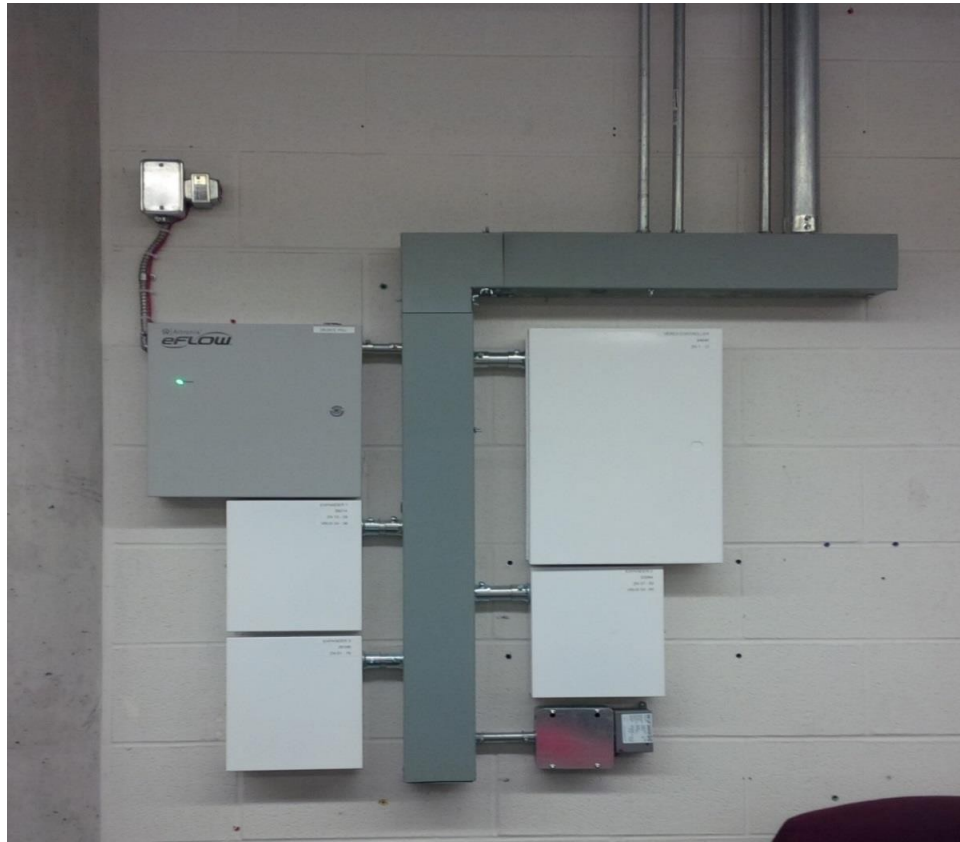
- .1 Prior to start of work, review identification nomenclature and method with Consultant.
- .2 Identify and tag wiring, providing ease of reference on as-built drawings.
- .3 Identify each wire on both ends with wire number system.
- .4 Labels: Machine printed and legible.
- .5 Do not write on wires for purpose of permanent labelling.
- .6 Label detectors and door contacts with machine printed label (typically, white background and black lettering). Affix door contact labels to door frame in location confirmed with Owner and reviewed with Consultant.
- .7 Provide type written wiring legend for wiring circuits and zones for each panel box. Mount legend on inside of panel box door.
- .8 Provide label on panels and cabinets containing power supplies. Identify on labels, purpose of panel or cabinet, zones and model numbers for each controller, expansion board numbers, types and serial numbers of devices.
- .9 Label batteries with date of install.

3.04 FIELD QUALITY CONTROL

- .1 Manufacturer authorized technician to inspect, start-up, test and verify system upon completion of installation. Work includes but is not limited to following:
 - .1 Inspection of installation work.
 - .2 Initial start-up and programming.
 - .3 Verifying equipment installed is that designated by Contract Documents.
 - .4 Verifying installation work is in accordance with Specifications.

- .5 Verify operation and event logging of each card reader location in operating scenarios including valid/invalid access card, expired card, disable reader, anti-pass back, communication failure, standalone mode.
- .6 Verify annunciation, acknowledge, cancel and event logging of each alarm point in system.
- .7 Verify successful operation of administrative menu features.
- .8 Verify proper operation of system after power brown-out, power failure, and power restoration.
- .9 Verify remote access to building site.
- .10 Verifying communications interconnection to and operation with central monitoring system equipment, and other building systems. Verifying compliance with CAN/ULC-S561.
- .11 In coordination and cooperation with fire alarm system tests, verifying emergency action of locked and unlocked doors in event of a fire.
- .12 Where applicable to installed system, testing alarms at key locations to ensure interface with CCTV system is active and activity is recorded when alarm occurs.
- .13 Verifying other remote alarm communications interconnections included with system.
- .14 Performing acceptance test and demonstration of system in presence of Consultant, Owner and Commissioning Agent.
- .2 Prepare as-builts identifying locations of central equipment, devices and interconnected systems.
- .3 Prepare testing and verification reports, signed by testing technicians. Report identifies location of each device and certifying test results of each device. Reports includes list of each device tested and results, and of overall system performance and the integrated systems.
- .4 Submit reports to Consultant.

3.05 SAMPLE HEADEND INSTALLATION



END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 American National Standards Institute/Telecommunications Industries Association (ANSI/TIA):
 - .1 ANSI/TIA-607-D-[2019], Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
 - .2 ANSI/TIA-568 Set-[2023], TIA Commercial Building Telecommunications Cabling Standard Set, including:
 - .1 ANSI/TIA-568.0-E-[2020], Generic Telecommunications Cabling for Customer Premises.
 - .2 ANSI/TIA-568.1- E-[2020], Commercial Building Telecommunications Cabling Infrastructure Standard.
 - .3 ANSI/TIA-568.2-D-[2018], Balanced Twisted-Pair Telecommunication Cabling and Components Standard.
 - .4 ANSI/TIA-568.3- E-[2022], Optical Fiber Cabling Components Standard.
 - .5 ANSI/TIA-568.4- E-[2022], Broadband Coaxial Cabling and Components Standard.
 - .6 Issued addenda.
 - .7 Richmond Hill Appendices Provided.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit pathways rough-in drawings coordinated and signed off by respective system vendors identifying routing of pathways, sizes of boxes and other requirements to accommodate installation of various systems equipment.

1.03 DESCRIPTION OF SYSTEM

- .1 Provide system of backboards, empty conduits, cable trays, outlet backboxes and pull boxes, accommodating installation of systems components and wiring.
- .2 Provide pathway provisions for systems serving areas. Refer to door detail drawings.
- .3 Structured cabling system is specified in another Division 27 Section.
- .4 System equipment and wiring is specified in other Sections or Divisions.
- .5 Telecommunication requirements are based on Category [6] UTP system and Owner Standards. Prior to start of work, review guidelines and requirements with Consultant.

2. Products

2.01 BACKBOARDS

- .1 G1S (good one side) construction grade fir plywood.
- .2 Containing no urea formaldehyde.
- .3 Painted finished fire rated plywood, or plywood entirely covered with 2 coats of flame-retardant prime coat paint. Flame spread rating in accordance with building code requirements.
- .4 Minimum 1219 mm wide x 2438 mm long x 20 mm thick, unless otherwise noted.
- .5 Openings for access to and use of electrical outlets and other equipment on walls.

2.02 CONDUITS

- .1 In accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings.
- .2 Climate Controlled Areas: EMT type, with press fit insulating nylon bushings at conduit ends and stubs, and insulating nylon, set screw fitting at boxes.
- .3 Exterior or other non-climate-controlled areas: PVC where permitted by electrical code, or rigid galvanized steel.
- .4 Sizing and number of runs as noted.
- .5 Main conduit pathways extending from Entrance Facilities (EF) to Central Equipment Rooms (CER) and from CER out to Telecom Rooms (TR): Minimum 100 mm diameter, unless otherwise noted.
- .6 Minimum Size: 27 mm EMT conduit. Provide increased sizing, suiting wiring filling requirements of electrical code, and system manufacturer requirements.
- .7 Bushings: Sized suiting conduit sizing.

2.03 OUTLET BOXES AND BACK BOXES

- .1 General Boxes: In accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Outlet Boxes and Back Boxes: Galvanized steel, flush mounted, 127 mm x 127 mm x 73 mm deep with two gang plaster rings. Sized for intended devices.
- .3 Card Readers: Coordinate box size and types with selected card reader manufacturer. Generally, galvanized steel, flush mounted, 127 mm x 127 mm x 73 mm deep with two gang plaster rings, suiting intended applications and in accordance with card reader manufacturer requirements.
- .4 Outdoor: Weatherproof and corrosion-resistant cast boxes.

2.04 PULL BOXES

- .1 General Boxes: In accordance with Section 26 05 31 - Splitters and Electrical Boxes.
- .2 Sizing: Not less than as indicated in Table 1 and Table 2.
- .3 Galvanized steel with hinged lockable cover.
- .4 Pull Cords: Polypropylene, 180 kg pull strength, in empty conduit runs.

2.05 MISCELLANEOUS

- .1 Cover Plates for Wall Outlet boxes and Backboxes: Suiting size of boxes. Review finishes with Consultant. Refer to requirements of respective box trade Sections.
- .2 Sleeves: In accordance with Section 26 05 00 - Common Work Results for Electrical.
- .3 Cable Bending Radii Provisions: Provide increased size of boxes to accommodate cable bending radii of category rating of UTP structured cabling system, in accordance with ANSI/TIA-568 Set of Telecommunications Standards. For additional requirements, refer to another Division 27 Section.
- .4 Acoustical Putty Pads: UL listed, 3.5 mm thick, non-hardening and permanently resilient.

2.06 DOOR LOCATIONS

- .1 Security Junction Boxes (SJB):
 - .1 300 mm X 300 mm X 100 mm deep galvanized steel SJB on secure side of each access-controlled portal.
 - .2 Screw down cover.
 - .3 Located above each access-controlled door on secure side of door (non-card-reader side) in drop ceiling (outside of door swing where possible), but accessible from 1.8 m (3 m maximum from finish floor to center of SJB).
 - .4 Conduit entries only at side of SJB with one side of SJB free of conduit.
 - .5 No conduit penetrating through back of SJB.
- .2 Review with Consultant, requirements at access-controlled doors for vertical conduit runs between SJB and door devices (lock, reader, door contact, accessibility paddles). Review also with door hardware vendors and security system vendors. Size conduit minimum 20 mm diameter. Increase conduit size where noted, and as required to accommodate cabling standards.
- .3 Run 27 mm conduit between SJB and telecom room and electrical room, as reviewed with Consultant.
- .4 Back boxes for door hardware, card reader and other security devices: As noted and reviewed with Consultant, door hardware vendors and security system vendor.

2.07 INDOOR VIDEO CAMERAS

- .1 Wall-mounted or ceiling-mounted, suiting intended applications, as reviewed with Consultant and security system vendor.
- .2 Wall-Mounted:
 - .1 Double gang back box.
 - .2 27 mm conduit runs, for one UTP cabling, to camera from telecom room and electrical room as reviewed with Consultant and security system vendor.
 - .3 27 mm conduit runs from device box to telecom room and electrical room as reviewed with Consultant and security system vendor.
- .3 Ceiling-Mounted:
 - .1 2 - double gang back boxes (one at camera location, one above on ceiling slab).
 - .2 27 mm conduit runs, for one UTP cabling, to camera from telecom room and electrical room as reviewed with Consultant and security system vendor.
 - .3 27 mm conduit runs from slab back box to telecom room and electrical room as reviewed with Consultant and security system vendor.
 - .4 Flex conduit from slab back box to camera location back box.

- .4 Review UTP CAT requirements with Consultant, which are typically in accordance with Division 27.
- .5 Provide connectivity for cameras in public zones, in conduit, back to telecom room and electrical room as reviewed with Consultant and security system vendor.

3. Execution

3.01 INSTALLATION - GENERAL

- .1 Coordinate and verify pathways standards and requirements with systems vendors responsible for providing various systems and associated equipment and wiring.
- .2 Comply with applicable installation in accordance with ANSI/TIA-568 Set of Telecommunications Standards.
- .3 Install empty conduit system, conduit nylon bushings, fish wires, plywood backboards, outlet boxes, pull boxes, sleeves, caps and miscellaneous accessories. Do not run security and surveillance - CCTV system cabling in cable tray. Run in dedicated conduits.
- .4 Refer to drawing detail for additional requirements and installation methods.
- .5 Ground and bond in accordance with ANSI/TIA-607-D and Section 27 05 26 - Grounding and Bonding for Communications Systems.
- .6 Provide sleeves in locations as noted, typically between rooms. Provide sleeves of minimum 100 mm diameter, unless otherwise noted. Equip sleeves with plastic bushings. Extend sleeves to protrude not more than 75 mm above finished floor.
- .7 Seal penetrations through fire-rated construction with firestopping and smoke seal materials in accordance with requirements of Division 07.
- .8 Coordinate requirements with telecommunication systems vendors, and review with Consultant.
- .9 Refer to drawings for additional installation requirements and specific sizing requirements.

3.02 INSTALLATION OF BACKBOARDS

- .1 Provide backboards in locations, mounted from 150 mm above finished floor and extending length of backboard.
- .2 Wall mount each backboard with fasteners suiting wall construction.
- .3 Install nails or screws, rising above surface of plywood.

3.03 INSTALLATION OF CONDUITS AND BOXES

- .1 Unless otherwise noted, install electrical steel boxes for wall-mounted outlets and ceiling-mounted outlets for device and camera locations. Include plaster ring with boxes. Connect with conduit and extend to locations as noted.
- .2 Mount outlet boxes as reviewed with Consultant, as follows:
 - .1 Flush-mounted in walls of finished areas.
 - .2 Flush-mounted in ceilings.
 - .3 Surface-mounted where connecting conduit is exposed in unfinished areas.
 - .4 Coordinating with systems equipment requirements.

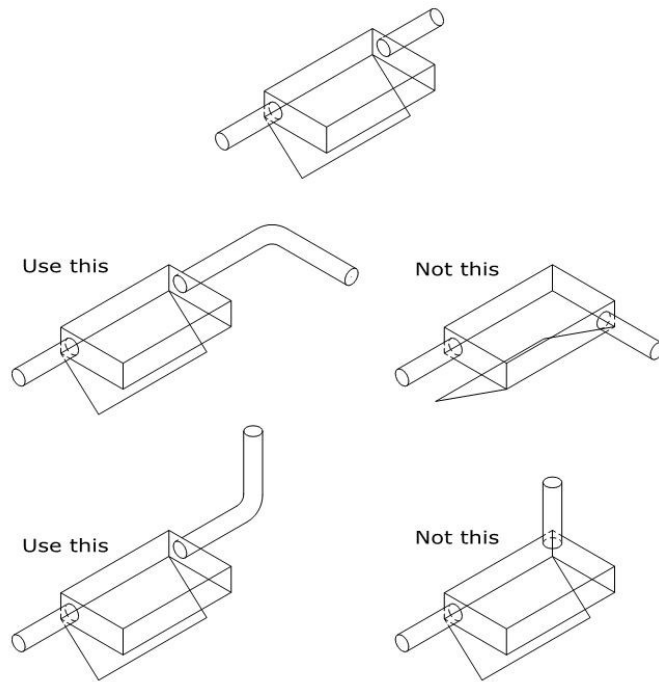
- .3 Provide power boxes and outlets coordinated for system equipment.
- .4 Provide cover plates for each box.
- .5 Run exposed conduits as high as possible, but accessible from workable height.
- .6 Make vertical transitions with gradual slope accommodating cable bending radii requirements.
- .7 For 2 contiguous 3 m sections of conduit, provide supports at minimum 3 points along length of conduits.
- .8 Terminate conduits with end connectors and plastic bushings.
- .9 Provide pull cords in empty conduit runs.
- .10 Make 90-degree transitions as sweeping bends accommodating cable bending radii requirements.
- .11 Bending radii for conduit less than 53 mm diameter: 6 times inner diameter of conduit.
- .12 Bending radii for conduit 53 mm diameter and greater: 10 times inner diameter of conduit.
- .13 Conduit runs exceeding 30 m in length, or with more than two - 90° bends: Equip with pull box installed at intermediate accessible location facilitating conductor installations.
- .14 Do not use double-gang electrical boxes as pull boxes.
- .15 Do not use pull boxes in lieu of a bend. Align conduits opposite each other within pull box. Refer to Figure 1, at end of Section.
- .16 Size pull boxes in accordance with security and surveillance system cabling requirements.
- .17 Refer to Section 26 05 31 - Splitters and Electrical Boxes for additional pull box installation requirements.
- .18 Coordinate requirements with security system vendor, and review with Consultant.

3.04 IDENTIFICATION

- .1 Provide product identification.
- .2 Equipment Main Nameplates: Size 4 unless otherwise noted.
- .3 Identify each box for intended service and location of opposite end of conduit pathway.
- .4 Identify conductors.

3.05 FIGURES AND TABLES

- .1 Figure 1 - Appropriate Pull Box Configuration:



END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA):
 - .1 CSA C22.2 No. 62368-1-[19], Audio/Video, Information and Communication Technology Equipment - Part 1: Safety Requirements (Binational standard with UL 62368-1).
 - .2 Richmond Hill Appendices provided

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section, including:
 - .1 Connection wiring schematic drawings, block system diagrams and sequence of operations.
 - .2 Samples of computer graphic displays, as applicable.
 - .3 Recommended installation and set-up procedures.
 - .4 List of recommended spare parts.
- .3 Submit copies of ULC listing certificates of installing security contractor.
- .4 Submit testing and verification reports.
- .5 Upon completion of Work, submit copies of software, software licenses and software manuals.

1.03 QUALITY ASSURANCE

- .1 System installation, testing and verification provided by ULC listed Security Contractor companies also designated as System Vendors.
- .2 System covered by active and unexpired ULC certificate.
- .3 System Vendor Qualifications:
 - .1 Established security systems contractors currently maintaining locally run and operated business for at least five years.
 - .2 Hold applicable provincial and local licenses.
 - .3 Regional Canadian Authorized Distributor for products and system proposed, with full manufacturer warranty privileges.
 - .4 Employ technicians trained and certified by product manufacturer of proposed system.

- .5 Maintain fully equipped service organization capable of performing inspection and service to system on 24-hour / 7-day basis. Maintain at facility, spare parts in proper proportion as recommended by manufacturer to maintain and service proposed supplied system.

2. Products

2.01 GENERAL

- .1 Security Contractor responsibilities include but are not limited to following:
 - .1 Providing system components and wiring, except otherwise noted.
 - .2 Providing system licenses.
 - .3 Performing system component and wiring terminations.
 - .4 Programming and start-up of system.
 - .5 Supplying system licenses, software and manuals.
 - .6 Performing system testing, inspection, commissioning and verification work upon completion of installation work.
 - .7 Preparing testing and verification reports, signed by manufacturer authorized technician.
 - .8 Provision of technical assistance to Division 26 Electrical Contractor with regards to conduit, box and wiring infrastructure installation requirements.
 - .9 Demonstration of installed system.
 - .10 Providing end user training and instructions.
- .2 Electrical Contractor responsibilities include but are not limited to following:
 - .1 Co-ordination of system work with Security Contractor, confirming responsibilities and requirements.
 - .2 Provision of system conduits and boxes, and power feeders, suiting system requirements, in accordance with Division 26 and system manufacturer requirements.
 - .3 Installing Security Contractor supplied system wiring in conduit, as coordinated with Security Contractor.
 - .4 Identification and labelling of each wiring run and components.
 - .5 Installing Security Contractor supplied system components, as coordinated with Security Contractor.
 - .6 Assisting Security Contractor with providing their work. Coordinate work requirements.
 - .7 Obtaining copies of testing and verification reports, reviewing reports, signing reports, and submitting to Consultant.
 - .8 Preparing as-built documentation, as coordinated with Security Contractor.

2.02 WIRING, CABLE, TERMINAL PANELS AND ACCESSORIES

- .1 System Wiring and Cabling Types: In accordance with system vendor recommendations and instructions.
- .2 Category rated UTP cable, patch panels and RJ 54 jacks: Category grade rate and as specified in Division 27. Use category rated UTP with PoE power over Ethernet technology for IP cameras.

- .3 Supply and install wire and cable, and additional conduit extensions or relocations, achieving specified CCTV system requirements.
- .4 Power supplies, mounting hardware, brackets and ancillary components: In accordance with system vendors requirements, completing installation of system.

2.03 ACCEPTABLE PRODUCT MANUFACTURERS/VENDORS

.1 Security System Integrators/Vendors:

- .1 Johnson Controls – Tyco.
- .2 Chubb Fire & Security.
- .3 Troy Life & Fire Safety.
- .4 Honeywell.
- .5 Stanley.
- .6 AATEL Communications.
- .7 AC Technical.

.2 CCTV Systems:

- .1 Pelco.
- .2 Johnson Controls – Tyco.
- .3 Honeywell.
- .4 Bosch.
- .5 Avigilon.

.3 IP Video Cameras:

- .1 Axis.
- .2 Pelco.
- .3 Avigilon.
- .4 Panasonic.
- .5 Sony.
- .6 Bosch.

3. Execution

3.01 INSTALLATION OF VIDEO SURVEILLANCE SYSTEMS

- .1 Provide components for system. Locate equipment and devices in locations. Prior to roughing-in, review locations with Consultant. Connect with power, control and video cables.
- .2 Determine final locations of cameras, providing optimum video surveillance and overall system performance, in accordance with Contract Document design.
- .3 Install cameras and lenses in locations. Secure adjustable pan/tilt brackets, pedestals and fixed in place housings, mechanically fastened to building structure independent of other support systems. Adjust cameras and lenses within housings, providing maximum video surveillance within each given location.
- .4 Install cameras such that field of view is not impacted by obstructions such as signage, clocks, displays, or advertising signs.

- .5 Coordinate with Division 27 telecommunications vendor and Owner IT personnel, requirements for structure cabling system and network electronics. Typically, products include UTP cabling, jacks, patch panels, PoE switches. PoE extenders and racks, for dedicated security system requirements. Provide products not supplied under work of Division 27 or Owner.
- .6 Coordinate final location of cameras and other equipment with Interior Designer and Architect, ensuring compatibility with their designs. Determine final locations and fields of view of each camera in operational walkthrough with Owner and Consultant during commissioning and prior to acceptance.
- .7 Mechanically fasten housings to building structure independent of other support systems. Do not fasten camera enclosures to suspended ceiling support systems. Provide enclosure type suiting installation location. Review locations with Consultant prior to roughing-in.
- .8 Connect cameras to structured cabling system and active PoE switches. For runs exceeding 90 m, provide PoE extenders and connect to extend distribution of communications and power to cameras.
- .9 Install PC terminal station, monitors and other control equipment and connect complete.
- .10 Install and mount equipment cabinets in locations. Mount equipment in cabinets and connect complete.
- .11 Install products in accordance with manufacturer specifications and instructions, with proper installation techniques and tools. Programme system programmed and field test, verifying optimum system performance.
- .12 Remove protective coverings from cameras and components.
- .13 Clean camera housing, system components and lens, free from marks, packing tape, and fingerprints, in accordance with manufacturer cleaning recommendations.
- .14 Document software programming sequences and include with as-built documentation.
- .15 Ground and bond system.

3.02 FIELD WIRING

- .1 UTP Camera Cabling: In accordance with Division 27 telecommunications cabling standards. Provide dedicated patch panels, switches/servers for security applications as reviewed with Consultant. Coordinate with Division 27 telecommunications vendor.
- .2 Run cabling from cameras back to equipment cabinets and terminate and connect to equipment. Run camera cables home run to local termination points. Do not run cables as daisy chained. Pull cables in continuous run with no splices. Leave spare cable (approximately 3 m) at each termination point, allowing for future re-orientation of cameras at each location.
- .3 Do not run wiring exposed. Run wiring in rigid conduits, or where noted in surface raceways. Do not run exposed wiring at monitoring locations. Provide cable covers of type confirmed with Owner and reviewed with Consultant.
- .4 Do not install wiring to underside of steel decks or to suspended ceiling support systems.
- .5 Surface mounted electrical boxes for devices in mechanical rooms and similar service rooms: FS style boxes with no knockouts.
- .6 Run wiring into cabinets as side or bottom conduit entry.
- .7 Run wiring into main panels in electrical splitter troughs, not as loose wiring.

- .8 Provide wiring in accordance with system manufacturer recommendations.

3.03 IDENTIFICATION LABELLING

- .1 Prior to start of work, review identification nomenclature and method with Consultant.
- .2 Identify and tag wiring, providing ease of reference on as-built drawings.
- .3 Identify each wire on both ends with wire number system.
- .4 Labels: Machine printed and legible.
- .5 Do not write on wires for purpose of permanent labelling.
- .6 Provide type written wiring legend for wiring circuits and zones.
- .7 Provide label on panels and cabinets containing power supplies. Identify on labels, purpose of panel or cabinet, zones and model numbers for each controller, expansion board numbers, types and serial numbers of devices.
- .8 Label and identify camera lenses and settings, and enclosures, recorded and cross referenced on as-built documentation.
- .9 Permanently tag power supplies and transformers at both ends with identification properly noted and cross referenced on as-built documentation.
- .10 Label and identify inputs and outputs, recorded and cross referenced on as-built documentation.
- .11 Label batteries with date of install.

3.04 FIELD QUALITY CONTROL

- .1 System manufacturer/vendor technician in conjunction with installing contractor is responsible for providing following:
 - .1 System programming.
 - .2 After installation inspection, testing, adjustments, verification and certification work.
- .2 Work includes but is not limited to following in field Work:
 - .1 Inspection of installation work.
 - .2 Initial start-up and programming.
 - .3 Testing and verification of installed equipment for conformance with Contract Documents.
 - .4 Verifying installation work is in accordance with manufacturer instructions, codes and AHJ.
 - .5 Set, adjust and verify field of view of each camera. Verify camera viewing angles and set-up. Perform with spot monitor at camera locations and at viewing monitor station.
 - .6 Verify operation and event logging of camera (resolution, storage time, frame rate).
 - .7 Verify operation of video recording equipment.
 - .8 Verify annunciation, acknowledge, cancel, and event logging of each alarm point in system.
 - .9 Verify successful operation of administrative menu features.

- .10 Verify proper operation of system after power brown-out, power failure, and power restoration.
- .11 Verifying operation of system with network infrastructure of Division 27, and including testing of UTP cable installations for:
 - .1 Continuity including open/short and ground short, polarity and pair transpositions.
 - .2 DC loop resistance.
 - .3 Length using TDR.
- .12 Testing of sequence of operation of system with integrated systems and equipment.
- .13 Where applicable to installed system, testing alarms at key locations to ensure interface with access control and security intrusion systems are active and activity is recorded when alarm occurs.
- .14 Verifying other remote alarm communications interconnections included with system.
- .15 Performing acceptance test and demonstration of system in presence of Consultant, Owner, and Commissioning Agent.
- .3 Prepare as-builts identifying locations of central equipment, devices and interconnected systems.
- .4 Prepare testing and verification reports, signed by testing technicians. Report identifies location of each device and certifying test results of each device. Reports includes list of each device tested and results, and of overall system performance and the integrated systems.
- .5 Submit reports to Consultant.

END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S301-[Edition 3, 2018], Standard for Signal Receiving Centres Configurations and Operations.
 - .2 CAN/ULC-S302-[Edition 2, 14-REV1], Standard for the Installation, Inspection and Testing of Intrusion Alarm Systems.
 - .3 CAN/ULC-S561-[Edition 3, 2020-REV1], Standard for Installation and Services for Fire Signal Receiving Centres and Systems.
 - .4 Richmond Hill Appendices provided

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings
 - .1 Submit shop drawings for products of this Section.
 - .1 Connection wiring schematic drawings, block system diagrams and sequence of operations.
 - .2 Samples of computer graphic displays, as applicable.
 - .3 Door functionality and schedule of operation of each secured door.
 - .4 Recommended installation and set-up procedures.
 - .5 List of recommended spare parts.
- .3 Submit copies of ULC listing certificates of installing security contractor.
- .4 Submit testing and verification reports.
- .5 Upon completion of Work, submit copies of software, software licenses and software manuals.

1.03 QUALITY ASSURANCE

- .1 System installation, testing and verification provided by ULC listed Security Contractor companies also designated as System Vendors.
- .2 System covered by active and unexpired ULC certificate.
- .3 System Vender Qualifications:
 - .1 Established security systems contractors currently maintaining locally run and operated business for at least five years.
 - .2 Hold applicable provincial and local licenses.
 - .3 Regional Canadian Authorized Distributor for products and system proposed, with full manufacturer warranty privileges.

- .4 Employ technicians trained and certified by product manufacturer of proposed system.
- .5 Maintain fully equipped service organization capable of performing inspection and service to system on 24-hour / 7-day basis. Maintain at facility, spare parts in proper proportion as recommended by manufacturer to maintain and service proposed supplied system.

2. Products

2.01 GENERAL

- .1 Provide systems in accordance with applicable requirements of:
 - .1 CAN/ULC-S301.
 - .2 CAN/ULC-S302.
 - .3 CAN/ULC-S561.
- .2 Security Contractor responsibilities include but are not limited to following:
 - .1 Providing system components and wiring, except otherwise noted.
 - .2 Performing system component and wiring terminations.
 - .3 Programming and start-up of system.
 - .4 Supplying system licenses, software and manuals.
 - .5 Performing system testing, inspection, commissioning and verification work upon completion of installation work.
 - .6 Preparing testing and verification reports, signed by manufacturer authorized technician.
 - .7 Provision of technical assistance to Division 26 Electrical Contractor with regards to conduit, box and wiring infrastructure installation requirements.
 - .8 Demonstration of installed system.
 - .9 Providing end user training and instructions.
- .3 Electrical Contractor responsibilities include but are not limited to following:
 - .1 Co-ordination of system work with Security Contractor, confirming responsibilities and requirements.
 - .2 Provision of system conduits and boxes, and power feeders, suiting system requirements, in accordance with Division 26 and system manufacturer requirements.
 - .3 Installing Security Contractor supplied system wiring in conduit, as coordinated with Security Contractor.
 - .4 Identification and labelling of each wiring run and components.
 - .5 Installing Security Contractor supplied system components, as coordinated with Security Contractor.
 - .6 Assisting Security Contractor with providing their work. Coordinate work.
 - .7 Obtaining copies of testing and verification reports, reviewing reports, signing reports, and submitting to Consultant.
 - .8 Preparing as-built documentation, as coordinated with Security Contractor.

2.02 ACCEPTABLE PRODUCT MANUFACTURERS / VENDORS

- .1 Security System Integrators / Vendors:
 - .1 Johnson Controls – Tyco.
- .2 Security Systems:
 - .1 Johnson Controls – Tyco – DSC

3. Execution

3.01 INSTALLATION OF SECURITY INTRUSION ALARM SYSTEM

- .1 Provide components for system. Locate control unit, remote keypads, graphic display, and devices in locations. Connect panels with power wiring.
- .2 Locate panels, expansion nodes, modules and other control devices in accessible locations of service rooms reviewed with Consultant. Do not locate in ceiling spaces.
- .3 Coordinate system requirements with integrated systems and work of other trades.
- .4 Program system to accommodate connected devices and zones, plus specified spare capacity. Prior to start of work, confirm zoning and sequence of operation of system with Owner and review with Consultant.
- .5 Provide keypads complete with protective cover, flush in wall locations with backboxes.
- .6 Provide door alarm contacts in doors/frames as detailed and as coordinated with General Contractor and Consultant. Coordinate installation with trade providing doors/frames such that frames are supplied with integral boxes for mounting of flush contacts and type of contacts match door construction. Install two contacts on double doors. Except for double door contacts, each door contact annunciated as distinct zones.
- .7 Provide wiring in conduit and run between contacts and system panel. Terminate wiring and make connections.
- .8 Coordinate connections to electric strikes, electromagnetic locks, door position switches, and door operators with door hardware vender and General Trades Contractor. Provide wiring in conduit and run between door hardware components and panel. Terminate wiring and make connections.
- .9 Mount motion detectors providing coverage of areas. Secure base plate of each detector to flush backbox and connect with wiring. After furnishings are in place, adjust sensitivity, providing coverage of areas. Install detectors with indicating LED programmed active. Program detection devices as instant zones.
- .10 Adjust each detector to suit specific coverage areas and in accordance with manufacturer recommendations.
- .11 Adjust motion detector or glass break detector setup deficiencies identified during commissioning process.
- .12 Provide alarm horns and mount in locations and connect complete. Flush mount in finished areas.
- .13 Prior to roughing-in, review locations with Consultant.
- .14 Provide system wiring in conduit from system control panel to telephone equipment backboard for system monitoring via ULC Listed Central Monitoring Station. Connect complete. Perform connections to central monitoring station, in accordance with CAN/ULC-S561.

- .15 Provide system wiring in conduit from fire alarm panel to system control panel for connection of fire alarm and trouble outputs.
- .16 Ground and bond system.
- .17 Ground cable shield wiring on panelboard side of wiring run, not at device.
- .18 For installation of access control components, refer to Section 28 10 00 - Access Control.

3.02 FIELD WIRING

- .1 Wire each device as distinct zone with end of line resistors.
- .2 Do not wire devices as combination zones except for multiple-door entrances.
- .3 Wire door contacts as one zone, except for contacts on double doors.
- .4 Wire devices as separate runs and not daisy chained.
- .5 Run wiring in rigid conduits, or where indicated on drawings in cable tray or surface raceways.
- .6 Do not run wiring exposed.
- .7 Do not install wiring to underside of steel decks.
- .8 Surface mounted electrical boxes for devices in mechanical rooms: FS style boxes with no knockouts.
- .9 Run wiring into cabinets as side or bottom conduit entry.
- .10 Run wiring into main panels in electrical splitter troughs, not as loose wiring.
- .11 Provide wiring in accordance with system manufacturer recommendations.

3.03 IDENTIFICATION LABELLING

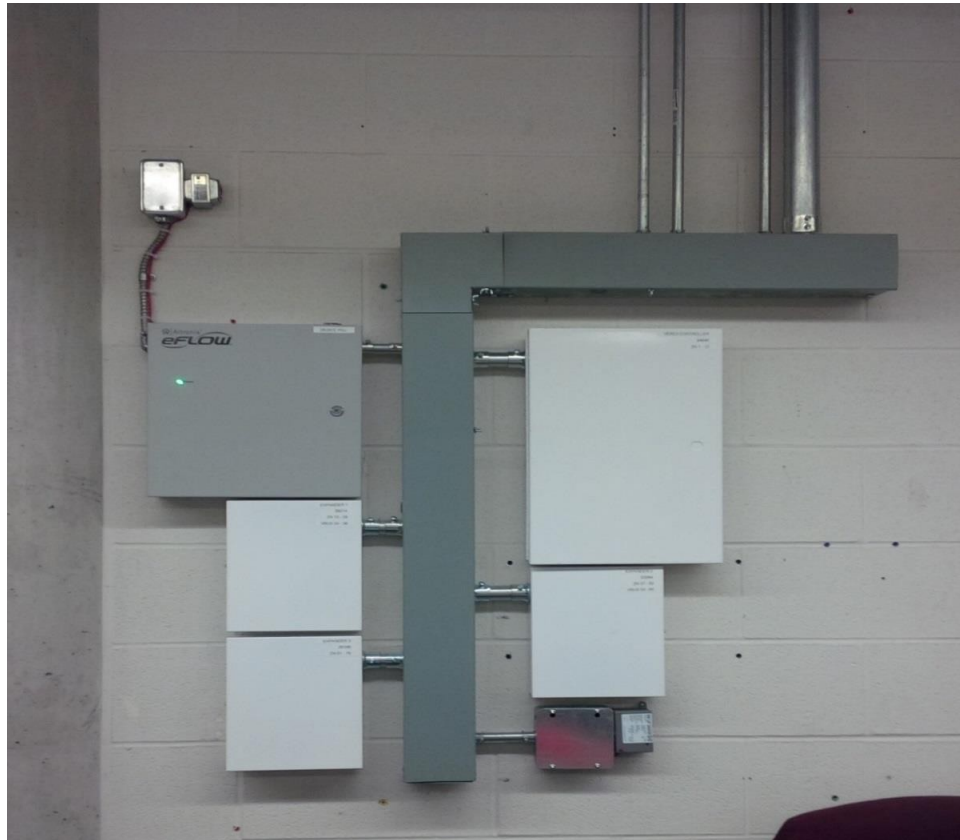
- .1 Prior to start of work, review identification nomenclature and method with Consultant.
- .2 Identify and tag wiring, providing ease of reference on as built drawings.
- .3 Identify each wire on both ends with wire number system, as reviewed with Consultant.
- .4 Labels: Machine printed and legible.
- .5 Do not write on wires for purpose of permanent labelling.
- .6 Label detectors and door contacts with machine printed label (typically, white background and black lettering). Affix door contact labels to door frame in location confirmed with Owner and reviewed with Consultant.
- .7 Provide type written wiring legend for wiring circuits and zones for each panel box. Mount legend on inside of panel box door.
- .8 Provide label on panels and cabinets containing power supplies. Identify on labels, purpose of panel or cabinet, zones and model numbers for each controller, expansion board numbers, types and serial numbers of devices.
- .9 Label batteries with date of install.

3.04 FIELD QUALITY CONTROL

- .1 Manufacturer authorized technician to inspect, start-up, test and verify system upon completion of installation. Work includes but is not limited to following:
 - .1 Inspection of installation work.

- .2 Initial start-up and programming.
- .3 Verifying equipment installed is that designated by Contract Documents.
- .4 Verifying installation work is in accordance with manufacturer instructions, codes and AHJ.
- .5 Verify operation and event logging of each controlled door hardware and detector connected to system panel.
- .6 Verify coverage areas of detectors.
- .7 Verify annunciation, acknowledge, cancel, and event logging of each alarm point in system.
- .8 Verify successful operation of administrative menu features.
- .9 Verify proper operation of system after power brown-out, power failure, and power restoration.
- .10 Verifying communications interconnection to and operation with central monitoring system equipment, and other building systems. Verifying compliance with CAN/ULC-S561.
- .11 Verifying other remote alarm communications interconnections included with system.
- .12 Performing acceptance test and demonstration of system in presence of Consultant, Owner, and Commissioning Agent.
- .2 Prepare as-builts identifying locations of central equipment, devices and interconnected systems.
- .3 Prepare testing and verification reports, signed by testing technicians. Report identifies location of each device and certifying test results of each device. Reports includes list of each device tested and results, and of overall system performance and the integrated systems.
- .4 Submit reports to Consultant.

3.05 SAMPLE HEADEND INSTALLATION



END OF SECTION

1. General

1.01 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA):
 - .1 CSA C22.1-[24], Canadian Electrical Code (CEC), Part 1 ([26th] Edition), Safety Standard for Electrical Installations.
- .2 National Research Council Canada (NRC):
 - .1 National Building Code of Canada (NBC), [2020].
- .3 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S524-[2019], Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S525-[2023], Standard for Audible Signal Devices for Fire Alarm Systems, Including Accessories.
 - .3 CAN/ULC-S526-[2023], Standard for Visible Signal Devices for Fire Alarm and Signaling Systems, Including Accessories.
 - .4 CAN/ULC-S527-[2023], Standard for Control Units for Fire Alarm Systems.
 - .5 CAN/ULC-S528-[2023], Standard for Manual Stations for Fire Alarm Systems, Including Accessories.
 - .6 CAN/ULC-S529-[2023], Standard for Smoke Detectors for Fire Alarm Systems
 - .7 CAN/ULC-S530-[M91-REV1], Standard for Heat Actuated Fire Detectors for Fire Alarm Systems.
 - .8 CAN/ULC-S537-[2019-REV1], Standard for Verification of Fire Alarm Systems
 - .9 CAN/ULC-S541-[2023], Speakers for Fire Alarm and Signaling Systems, Including Accessories
 - .10 CAN/ULC-S561-[2021], Standard for Installation and Services for Fire Signal Receiving Centres and Systems
 - .11 CAN/ULC-S1001-[2023], Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems.
 - .12 Richmond Hill Appendices provided

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section, including:
 - .1 Detail assembly and internal wiring diagrams for control units, consoles and auxiliary cabinets. Identify dimensions and layouts.
 - .2 Overall system riser diagram identifying control and annunciation equipment, devices, zones, special conductors and raceways, and integration to other building equipment and systems.

- .3 Overall system riser wiring diagram identifying control equipment, initiating zones, signaling circuits, terminations, terminal numbers, and conductors.
 - .4 Details for devices.
 - .5 Details and performance specifications for control, annunciation and peripherals with item-by-item cross reference to Specification for compliance.
 - .6 Sample graphic displays and nomenclature.
 - .7 Step-by-step operating sequence, cross referenced to logic flow diagram.
 - .8 Annunciator schedules.
- .3 System Software:
- .1 Submit final version of custom system software in format reviewed with Consultant.
 - .2 Include copy in system O & M manuals.
- .4 Submit verification that system supplying and programming vendor is manufacturer authorized, trained and certified local regional vendor.
- .5 Submit copy of ULC certificate verifying that system installation, testing and verification vendor is ULC listed fire alarm contractor.
- .6 Submit compliance certificates, and testing and verification reports.

1.03 QUALITY ASSURANCE

- .1 Products provided directly by system manufacturers or by system manufacturer authorized and certified regional vendors.
- .2 System vendor is authorized and trained by system manufacturer to calculate, design, install, test and maintain system.
- .3 System installation, testing and verification performed by ULC listed fire alarm contractor.
- .4 System covered by active and unexpired ULC certificate.

1.04 SPARE PARTS

- .1 Supply following spare parts:
 - .1 Extra Stock Materials: Submit 2 spare glass rods for each manual station using glass rods for operation.

2. Products

2.01 FIRE ALARM SYSTEM VENDOR REVIEW

- .1 With system manufacturer or manufacturer authorized vendor, review issued Bid Documents for fire alarm system design and verify if any recent code requirements are in effect and need to be accommodated in work. Verify that proposed manufacturer devices provide proper coverage in areas of work. Review systems work on drawings and if any issues, errors or omissions are found, advise Consultant minimum 7 working days prior to close of Bid submission.

2.02 ADDRESSABLE FIRE ALARM SYSTEMS

- .1 Microprocessor-based, single stage, zoned, modular, electrically supervised, addressable, fire alarm system, with general features as follows:
 - .1 Supplied and programmed by manufacturer authorized, trained and certified local regional vendor.
 - .2 Listed as products of single manufacturer under appropriate category by ULC.
 - .3 Products supplied by single vendor/manufacturer.
 - .4 CSA certified, and ULC listed and labeled: System power supplies and other components where required AHJ. Suitable for fire alarm applications.
 - .5 In conjunction with system work and installation, provided in accordance with specific application requirements of AHJ and of following:
 - .1 CSA C22.1 and provincial electrical code.
 - .2 NBC and provincial building code.
 - .3 ULC S500 series of standards listed in Part 1 - Reference Standards.
 - .4 CAN/ULC-S1001.
 - .5 Building permit applications for approvals.
 - .6 Operation of system does not require personnel with special computer skills.
 - .7 System is of modular design, allowing future expansion with minimum of hardware additions and system interruptions.
- .2 Main System Components
 - .1 Control panel with central processing unit (CPU).
 - .2 Remote annunciators.
 - .3 Initiating devices (manual stations, heat/smoke/flame detectors).
 - .4 Alarm indicating devices (horns, strobes).
 - .5 Interfaces and interconnections to auxiliary building systems.
 - .6 Wiring in conduit.
 - .7 Fire-rated mineral insulated copper-clad cables.
- .3 System Software:
 - .1 Custom programmed with sequence of operations suiting intended project requirements. Programme custom sequence of operation as outlined in Part 3 of this Section.
 - .2 Programming performed by manufacturer authorized technician.
 - .3 Include for system programming changes required for duration of project.
 - .4 Include for additional one onsite system reprogramming sessions (duration minimum 4 hours) for any after verification/commissioning revisions required by AHJ or Consultant.
 - .5 Include for system programming changes required for final acceptance and certification of entire system and project work.
- .4 Control Panels:
 - .1 In accordance with CAN/ULC-S527.
 - .2 Provides supervision, monitoring and annunciation of following functions:
 - .1 Fire alarm control.
 - .2 Fire alarm annunciation.

- .3 Supervisory and trouble annunciation.
- .3 System capacity: For schedule of zones and system points, plus minimum additional spare 25% zones and 25% points.
- .4 Surface-mounted when installed in unfinished areas.
- .5 Recessed-mounted when installed in finished areas.
- .6 Solid-state microprocessor-based technology with LCD for display of system information, and integral LED annunciator with alarm and trouble LEDs for each scheduled zones and annunciation points. Where remote annunciators are provided, annunciations common with control panel.
- .7 System points monitored and controlled include:
 - .1 Initiating Circuit Devices: Addressable analogue detectors identified with detector type and detector values.
 - .2 Conventional addressable or zone connected smoke, heat and flame detectors.
 - .3 Addressable manual stations.
 - .4 Sprinkler devices.
 - .5 Control Circuits For: Audible devices, visual devices, fan controls, elevator controls, electromagnetic lock controls, and other similar operations.
- .8 Dead front, modular cabinet assembly with trim, hinged door with full glazing, lock with keys.
- .9 Door provides access to operator controls but does not expose live electrical connections.
- .10 Controls, indicators, and operating instructions clearly visible through viewing window.
- .11 Electrical connections are front access through removable inner protective cover.
- .12 Panel allows for loading or editing of special instructions and operating sequences as required and performs onsite programming, accommodate expansion and changes required by AHJ, or by Consultant.
- .13 Software operations and instructions stored in non-volatile programmable memory in event of loss of primary and secondary power.
- .14 Onsite programming changes to fire alarm system is password protected.
- .15 During construction stage, submit proposed program and custom label changes to AHJ for approval and to Consultant for review and recommendations for acceptance.
- .16 LCD Display: LCD display indicates alarms, supervisory service conditions, and troubles, and includes minimum 8 lines x 20 characters.
- .17 Chronologically logging and storing events in alarm log and trouble log for minimum 300 events each. Historical logs stored in CPU memory and protected by lithium battery that is supervised for low battery condition. Each recorded event includes time and date of that event occurrence. Alarm log file is separate from trouble log file. User able to generate a report of both logs upon request.
- .18 Panel includes but is not limited to following:
 - .1 Minimum 15 hardwired circuit capacity.
 - .2 Local energy, shunt master box, or reverse polarity remote station connection.
 - .3 Form C trouble contact.

- .4 Earth ground supervision circuit.
- .5 Front panel ground fault isolation control.
- .6 Intelligent power supply.
- .7 Automatic battery charger.
- .8 Standby batteries.
- .9 Resident non-volatile programmable operating system memory for operating requirements.
- .10 Programmable multi-function keys with status LEDs.
- .11 Red fire alarm LED and acknowledge button.
- .12 Yellow supervisory service LED and acknowledge button.
- .13 Yellow trouble LED and acknowledge button.
- .14 Green power on LED.
- .15 Alarm/signal silence LED and button.
- .16 System reset button.
- .17 Operator interface keypad for manual control and system information access.
- .18 Addressable interface control modules, suiting intended applications.
- .19 Serial DACT module.
- .20 Supervised annunciator circuit.
- .19 Hardwired initiation and control circuits individually configurable, onsite, in any combination, providing initiating circuit, signal circuit, or auxiliary control circuit operation. These circuits include Ground Fault Isolation Relay, isolated via front panel keyboard without having to remove field wiring.
- .20 Initiation circuits are individually configurable on site to provide either alarm/trouble operation, alarm only, trouble only, current limited alarm, no alarm, normally closed device monitoring, non-latching monitoring circuit or an alarm verification circuit.
- .21 Notification appliance circuits (NAC), activate and power horn/strobe circuits, and are independently supervised and fused such that fault on one circuit does not affect operation of other circuits. Configure NACs as Class "B" wiring, current limited.
- .22 Supports RS-232-C I/O ports. CPU data output to I/O ports are in parallel ASCII format at field adjustable baud rates.
- .23 Panel includes circuitry and devices for transmitting alarm signal to devices provided by others (Owner arranged monitoring company), sending alarm signal to Fire Department or to outside private protection company, in accordance with CAN/ULC-S561. Coordinate requirements with monitoring company and/or security company, as confirmed with Owner.
- .24 Serial digital alarm-communicating transmitter (SDACT) module mounts internally to and communicates directly with fire alarm control panel. SDACT monitors status of host fire alarm control panel and its connections to central station-monitoring receiver. When status changes require information to be reported, SDACT provides per point message, (i.e. every addressable device within system on individual basis), that can assist central station in more accurately implementing required response. Typical information reports include alarms, troubles, and supervisory conditions with specific point identification.
- .25 Provide isolators between building dividing walls, where required by AHJ and as recommended by system vendor.

- .26 Supervised wiring to remote annunciators: Supervised for open and ground conditions.
- .5 Amplifiers and Tone Generators:
 - .1 Supply signals for tones to audible devices and are sized accommodating audible device loads (assume 1 watt tapping for determination of amplifier capacity). Amplifiers continuously supervised for proper operation. Size amplifiers to include 20% power output spare future capacity.
- .6 Walk-Test with History Logging:
 - .1 Software and programming providing one-person system testing.
 - .2 Initiating walk-test mode automatically disconnects auxiliary control circuit relays, and creates a system trouble indication on control panel.
 - .3 Alarm activation of any initiating device causes audible signals to pulse one round of code over alarm signal circuits identifying zone of alarm to testing technician without having to return to control panel. Alarm-initiating zone is silently logged as being tested in historical data file. Panel automatically resets itself after logging of alarm.
 - .4 Any momentary opening of initiating or indicating appliance circuit causes audible signals to sound for 4 seconds to indicate trouble condition. Trouble condition is silently logged as trouble condition in historical data file. Panel automatically resets itself after logging of trouble condition.
 - .5 When walk-test feature is on for inappropriate, (programmable), amount of time, system reverts to normal mode automatically.
 - .6 Actuation of walk-test program does not require special tools and is user friendly programmable by authorized user.
- .7 Addressable Device Network:
 - .1 System provides communication with addressable initiating devices. These devices are annunciated on control panel main display. Annunciation includes following conditions for each point:
 - .1 Zone/Device Location.
 - .2 Type of Device.
 - .3 Detector Status (Normal/Alarm/Trouble).
 - .4 Device Missing/Failed.
 - .2 Minimum of 100 addressable devices may be multi-dropped from single pair of wires. System features in-field reprogramming to add or delete devices.
 - .3 Communication format is completely digital poll/response protocol, using parity data bit error checking routines for address codes and check sum routines for data transmission portion of protocol.
 - .4 Each addressable device uniquely identified by address code entered on each device at time of installation. Use of jumpers to set address is not acceptable.
 - .5 System supports 100% of addressable devices in alarm or operated at same time, under both primary (AC) and secondary (battery) power conditions. System supports 100% of point capacity in alarm simultaneously.

- .6 System allows line distance of up to 750 m to furthest addressable device on Class A communications circuit. Run each addressable loop wired Class A and run in Class A conduit system with return run separated by minimum of 600 mm from primary run. Install isolator modules so that wiring fault (short, open, or ground) within one floor area does not prevent normal operation of other addressable devices on other floor areas.
- .8 Devices - General
 - .1 Recommended by system manufacturer, suiting intended applications.
 - .2 Non-climatic-Controlled Areas:
 - .1 Weatherproof, corrosion-resistant and ULC listed for use in below freezing temperatures, and as recommended by system manufacturer for use for intended applications.
 - .2 Where electronics are not recommended for cold temperature applications, remotely locate addressable modules in closest heated areas and connect to respective device in non-climate-controlled areas, in accordance with manufacturer recommendations.
 - .3 Audible and Visual Devices: Determine output settings of dBA audibility and candela visibility, suiting intended applications. Size power supplies and amplifiers, accordingly with spare capacity and maximum device loading as specified.
 - .4 Areas of high abuse such as public parking areas, publicly accessible areas: Vandal-resistant, tamperproof and vermin-proof features such as guards, fasteners requiring use of special tools and fasteners not exposed.
- .9 Power Requirements:
 - .1 Control panel accepts 120 volts, 60 Hz as primary source of power for system and additionally provides 24 volts regulated output, current limited distributed system power. Primary power failure or power loss (less than 102 volts) activates common trouble sequence.
 - .2 Direct current (DC) emergency power supply consists of battery power source to supply sufficient standby capacity to operate entire system upon loss of normal power. Emergency power supply controls, battery charger and batteries provide automatic uninterruptible transfer of power to loads during primary power failure or loss. During normal operating conditions, fault in battery charging circuit or short or open in battery leads, activates common trouble sequence. Continuous supervision of wiring for initiating and alarm circuits is maintained during power failure.
 - .3 Power supplies include automatic "Brownout" transfers to standby batteries when supply voltage falls to below set limit.
 - .4 System Standby Capacity:
 - .1 Sufficient standby capacity operates entire system upon loss of normal power in normal supervisory mode for period of minimum [24] hours, and immediately following, full load power (defined as power required for full signalling activation of devices both visual and audible for full alarm conditions) for not less than [30 minutes].
 - .2 Verify requirements with AHJ and amend suiting requirements. Such amendments to not lessen specified requirements.
 - .3 Test and demonstrate capacity and performance requirements. Refer to Part 3 for additional requirements.

- .4 System automatically transfers to standby batteries upon power failure. Battery charging and recharging operations are automatic.
- .5 Standby Power Batteries and Chargers:
 - .1 Maintenance free, sealed gel cell batteries, providing standby power.
 - .2 Supervision of low battery condition or disconnection of batteries, audibly and visually annunciated at control panel.
 - .3 Connected with battery chargers having following operating characteristics:
 - .1 Ability to charge batteries to 70% of their capacity within 12 hours.
 - .2 Compatible with type of batteries.
- .6 Circuits requiring system operating power are individually fused.
- .7 Transient voltage surge protection device (SPD) provides protection to system electronics from surges and spikes on power lines. Type of SPD units are as recommended by fire alarm system manufacturer.
- .8 Include with system, transformers to power ancillary devices and hardware.
- .10 Panel Enclosures:
 - .1 Minimum NEMA 1 with additional sprinkler-protection provisions including ventilation louvers designed to protect live components from water spray of activated sprinklers.
 - .2 Drip shield for surface-mounted panels.
 - .3 Wall-mounted, enamel finished, steel cabinets.
 - .4 Flush trim where flush-mounted.
 - .5 Where installed in finished public areas: Flush wall-mounting and coordinated with architectural finishes.
 - .6 Prior to roughing-in, review finishes and requirements with Consultant.

2.03 REMOTE ANNUNCIATORS

- .1 Flush wall-mounting, LED type annunciators with features as follows:
 - .1 Alarm LED for each fire zone.
 - .2 Supervisory LED for each sprinkler and standpipe zone.
 - .3 Each zone shown separately and identified by different colour.
 - .4 Alarm and supervisory zones identified with white lamacoid plate with black lettering.
 - .5 LEDs of high intensity types and supervised.
 - .6 Trouble buzzer.
 - .7 Anodised aluminium flush mounting trim with back box.
 - .8 Tamper-resistant mounting hardware.
- .2 Multi-coloured passive graphic display as follows:
 - .1 Electronically stored building floors and zones outlines, printed on dimensionally stabilized clear film with 3 mm thick clear impact resistant acrylic shield with UV protection.

- .2 Building and floor outlines and zone areas designation depicted by black border with each zone area represented by separate colour. Egress corridors illustrated with black dotted design with zone colour shown behind pattern. Prior to ordering, review colours and outlines with Consultant.
- .3 Exit doors, fire hose cabinets, Siamese connections, elevators, sprinkler pump, gas shut off valves, and other fire safety products, indicated.
- .4 "YOU ARE HERE" notation in red.
- .5 Minimum of 6 colours utilized in display.
- .6 Anodized aluminum frame (minimum 600 mm x 1 m), matching finish of remote annunciator as reviewed with Consultant.
- .7 Tamper-resistant mounting hardware.
- .8 Approved by AHJ.

2.04 MANUAL STATIONS

- .1 In accordance with CAN/ULC-S528.
- .2 Addressable system manual stations are addressable types with integral addressable electronic modules that monitors status and communicates changes to connected control panel. Stations include diagnostic LEDs and distinct address set on station at time of installation.
- .3 Single Stage Manual Stations:
 - .1 Single action, non-coded, semi-flush mounted type.
 - .2 Die cast metal construction with red enamel finish and "PULL IN CASE OF FIRE" lettering.
 - .3 Front break-glass rod, tamperproof reset function, and one set of N/O contacts.
 - .4 Contacts close when handle is pulled down with single action, breaking glass rod and activating fire alarm condition.
- .4 Manual stations in areas designated as barrier free type, are operated with no grip handle feature, approved by AHJ and as recommended by system manufacturer.
- .5 Stations located in areas of high abuse or where designated with guard, are equipped with ULC listed and labelled, hinged clear Lexan cover and integral battery-operated alarm where required by AHJ.
- .6 Include following key operated stations in areas of high exposure to misuse and vandalism.

2.05 DETECTORS

- .1 Thermal Detectors:
 - .1 In accordance with CAN/ULC-S530.
 - .2 Surface ceiling-mounted.
 - .3 Low silhouette design and twist-lock mounting to base.
 - .4 LED status indication.
 - .5 Field configurable mounting mechanism prevents unauthorized removal.
 - .6 Types as noted for following:
 - .1 Combination 9 C° per minute rate of rise and 57°C fixed temperature detector types.
 - .2 57°C fixed temperature type.

- .7 Baseplate and wiring terminals, for mounting to standard 100 mm octagon box.
- .8 Cast guards for detectors as noted.
- .9 Alarm relay (Form C, SPDT), normally open contact, for auxiliary functions.
- .10 Where detector is tied to hold open devices, include auxiliary set of contacts. Coordinate work with supplier of hold open devices.
- .2 Products of Combustion Detectors:
 - .1 In accordance with CAN/ULC-S529.
 - .2 Surface ceiling mounted photoelectric type.
 - .3 Low silhouette design and plug-in mounting to base.
 - .4 Nominal sensitivity of 1.8% per foot.
 - .5 Integral LED alarm lamp.
 - .6 Integral circuitry performs functional tests of detection circuits every 40 seconds without use of smoke.
 - .7 Locking feature preventing unauthorized removal of unit head from base.
 - .8 Base plate and wiring terminals, for mounting to standard 100 mm octagon box.
 - .9 Cast guards for detectors where indicated.
 - .10 Alarm relay (Form C, SPDT), normally open contact, for auxiliary functions.
 - .11 Where detector is tied to hold open devices, include auxiliary set of contacts. Coordinate work with supplier of hold open devices.
- .3 Duct Type Smoke Detector Units:
 - .1 In accordance with CAN/ULC-S529.
 - .2 Photoelectric detector.
 - .3 Duct air sampling tube of suitable length for application.
 - .4 Magnetic activated test switch.
 - .5 Status LEDs.
 - .6 Form C auxiliary alarm relays.
 - .7 Remote alarm indicator assembly with LED type lamp mounted to single gang stainless steel faceplate.
 - .8 Remote test station for detectors in locations not easily accessible to test.
 - .9 Duct housing assembly: Consists of airtight housing mounted on side of duct and contains sensor base into which photoelectric sensor head is inserted.
 - .10 Units located within ductwork as indicated, and units within air intake ductwork: Include weatherproof housing with integral heater and thermostat control with alarm contacts for monitoring and annunciation of low temperature. Provide wiring in conduit back to control panel.
- .4 Equip detectors with dust cover, removed at time of verification, preventing dust and dirt entering smoke chamber during construction work.
- .5 Detector Bases:
 - .1 Various types of bases suiting respective intended applications. Confirm with system manufacturer and provide type for each intended application.
 - .2 Standard type: Equipped with wiring terminals, for mounting to standard 100 mm octagon box and complete with tamper-resistant mechanism, preventing unauthorized removal of unit head from base.
 - .3 Relay type: With features similar to standard type but includes auxiliary relay.

- .4 Audible type: With features similar to standard type but includes audible alarm sounder.
- .5 Isolator type: With features similar to standard type but includes line fault isolator.

2.06 AUDIBLE AND VISUAL DEVICES

- .1 General:
 - .1 Audible Signal Devices: In accordance with CAN/ULC-S525.
 - .2 Visual Signal Devices: In accordance with CAN/ULC-S526.
 - .3 Audible devices are of similar sound and pattern. Visual devices are of similar visual pattern.
 - .4 Devices include horns, strobes and combination units. Audible devices for same applications sound alike on system. Devices mount on wall back boxes. Back boxes supplied by system manufacturer, suiting specific devices and intended installation.
 - .5 Audibility levels and candela levels of devices are field selectable and adjustable. System vendor to select and adjust levels.
 - .6 In finished areas, devices typically mount to 100 mm square, 60 mm deep, back box. Where devices are surface-mounted, provide red or white finished surface back box with no knockouts. Review requirements with system manufacturer and provide suiting intended applications.
 - .7 Provide weatherproof box and tamperproof and weatherproof hardware for devices mounted exterior.
- .2 Horns, Strobes and Combination Horn/Strobe Units:
 - .1 Areas of Installation: Climate-controlled areas.
 - .2 Flush-mounting and surface-mounting, suiting intended applications.
 - .3 Horns:
 - .1 Temporal or continuous tones, suiting intended applications as reviewed with Consultant.
 - .2 Audible level: Minimum 94 dba @ 3 m at low setting and minimum 98 dba @ 3 m at high setting.
 - .3 Faceplate: Impact-resistant construction, finished in colour reviewed with Consultant.
 - .4 Strobes:
 - .1 Synchronized, suiting intended application with input polarized for standard reverse polarity supervision by fire alarm controls.
 - .2 Lexan lens with field changeable "FIRE" markings.
 - .3 Candela output intensity: Range from 15 cd to 110 cd, and to 177 cd for specific applications.
 - .5 Combination Units: Horns and strobes as specified with features above, and strobe factory mounted integral with horn.
 - .6 Backplates and Back Boxes: Galvanized steel construction, flush or surface wall-mounting, suiting intended mounted devices and intended applications.
- .3 Remote Lamp Units:
 - .1 Single gang stainless steel faceplate with LED indicating lamp, suiting mounting on standard wall box.

- .2 Unit remotely connected to smoke detector located in position where detector activated LED cannot be seen, such as under raised floors, in drop ceilings, above or in ductwork.
- .3 Smoke detectors include auxiliary connections suiting connection requirements in accordance with system manufacturer recommendations.
- .4 Suitable identification labelling on faceplate.
- .4 Fire Signs:
 - .1 Warning sign with slim line satin aluminium housing and with black face and red letters.
 - .2 "FIRE DO NOT ENTER" custom nomenclature, illuminated, flashing, 24-volt D.C.
 - .3 Signs equipped with upper and lower rows of long life LED illuminators rated for at least 100,000-hour life, flasher, and impact-resistant polycarbonate guard.
 - .4 Minimum Letter Size: "FIRE" – 50 mm high, "DO NOT ENTER" – 38 mm high.
 - .5 Lettering not visible until sign is energized.

2.07 MISCELLANEOUS

- .1 End-of-Line Resistors:
 - .1 End-of-line resistors for standard alarm and signalling circuits, sized for correct supervisory current flows in each circuit, in accordance with requirements of system manufacturer.
 - .2 End-of-line resistors mounted on impact-resistant nylon plate for mounting on standard single gang box and bear ULC label.
- .2 Isolators:
 - .1 Isolators provided in accordance with requirements of AHJ and installed in accordance with system manufacturer requirements, isolating and monitoring zones, loops, group of devices within building and between buildings.
- .3 Wiring:
 - .1 CSA certified and ULC listed and labeled wire and cable for fire alarm circuits.
 - .2 Colour coded, insulated solid copper conductors of type in accordance with electrical code and requirements of AHJ.
 - .3 Sized and installed in accordance with system manufacturer instructions.
- .4 Mineral insulated (MI) type, 2-hour fire rated, copper sheathed, copper conductors as specified in Section 26 05 19 - Low Voltage Electrical Power Conductors and Cables. Provide for following:
 - .1 Power, control and signal wiring in accordance with life safety requirements of building codes
 - .2 Power, control and signal wiring in accordance with life safety requirements of AHJ.
 - .3 Applications as noted, and as reviewed with Consultant.
 - .4 To and between each transponder/control panel.
 - .5 Addressable device circuits.

2.08 WARRANTY

- .1 Features:

- .1 1-year repair or replacement warranty on components.
- .2 Warranty begins upon substantial acceptance of project, or where applicable, phase of project. Provide extended warranty for system when used during construction stages and which covers period of construction before turnover.
- .3 Support of operational remote maintenance capability.
- .4 Repair response times for problems defined as routine addressed and corrected within 24 hours, excepting statutory holidays and weekends.
- .5 Repair response times for problems defined as major addressed and corrected within 4 hours, excepting statutory holidays and weekends.
- .6 Manufacturers of major components provide written confirmation of full warranty, extended warranty and service back-up in case of failure to perform or insolvency of successful supplier.
- .7 Maintain maintenance records for each system supplied, and submit monthly report containing time and date record of reported or detected problems, detail of corrective action taken and cause of problem.

2.09 ADDITIONAL DEVICES

- .1 Include for 2 additional horns and 2 additional strobe lights, each with 20 m of wiring in conduit, installation, programming, testing and verification. Install these additional devices in event of local fire/building inspector requiring additional coverage in certain areas.

2.10 ACCEPTABLE PRODUCT MANUFACTURERS/VENDORS

- .1 Fire Alarm System/Vendors:
 - .1 Edwards, (from Troy Life and Fire Safety, or Chubb Fire Safety).
 - .2 Johnson Controls formerly Tyco-Simplex, (from Johnson Controls [Tyco Integrated Fire & Security]).
 - .3 Siemens Building Technologies, (from Siemens).
 - .4 Honeywell - Notifier, (from Notifier authorized regional vendor).

3. Execution

3.01 INSTALLATION – GENERAL

- .1 Prior to start of Work, as part of shop drawing submission process, review with system manufacturer following:
 - .1 Device types, verifying selected type is suitable for intended applications.
 - .2 Selection of audible and visual devices with field adjustable settings, suiting installation areas and intended applications and are in accordance with referenced codes and standards, including CAN/ULC-S524.
 - .3 Locations and mounting heights of devices, verifying proper operation and coverage is in accordance with requirements of AHJ, referenced standards and codes.
 - .4 Device back box requirements, verifying size and depth is in accordance with system manufacturer recommendations for specific devices.
 - .5 Types of system wiring and required sizing taking in consideration intended applications and voltage drop.

- .6 System circuiting and device quantities for each circuit while maintaining limitations as specified.
- .7 Proposed system sequence of operation.
- .2 Advise Consultant of requirements of above that may necessitate revisions to design documents.
- .3 Provide fire alarm system for building. Install products and perform installation work in accordance with manufacturer instructions and recommendations. Install, test, verify, and certify system in accordance with specified referenced standards, specific references to CAN/ULC-S524, building codes, electrical codes, and as required by AHJ.
- .4 Obtain training from manufacturer representative on special installation procedures and including recommendations and instructions from system and device manufacturers. Install system equipment, devices and perform work in accordance with manufacturer instructions and requirements.
- .5 Arrange for fire alarm system manufacturer authorized technician to:
 - .1 Perform control panel, transponder, and annunciator work.
 - .2 Inspect related work by installing personnel.
 - .3 Perform system programming of initial installed system.
 - .4 After total completion of work and verification of system, but prior to turnover, include additional onsite software programming sessions for changes to system recommended by Consultant or Commissioning Agent.
 - .5 Review final software nomenclature with Consultant. Incorporate in software, final room names/area names/building names and equipment identification.
 - .6 At turnover, supply copy of system software in format reviewed with Consultant and submit copy to Consultant and include also with system O & M manuals.
- .6 Contact AHJ, in providing detailed description of Work and requirements for obtaining AHJ inspections and approvals.
- .7 Prior to roughing-in controls, panels and devices, review installation locations with Consultant.
- .8 Prior to ordering, review device finishes and colours with Consultant.
- .9 Prior to ordering, review identification products and signage requirements such as sizing, print types and sizing and nomenclature, with Consultant. Label devices as required by CAN/ULC-S524 and AHJ.

3.02 SEQUENCE OF OPERATION – SINGLE STAGE

- .1 Provide sequence of operation for fire alarm system as approved by AHJ and reviewed with Consultant. Review requirements with AHJ, fire plan and Consultant. Submit proposed graphic displays for reviews and approvals. Refer to additional requirements on drawings.
- .2 System equipment and software is flexible and easily programmed with sequences of operations. After approval of sequence of operation is made by AHJ and recommendation for acceptance is made by Consultant, program system and control panel, initiating series of pre-defined control actions.
- .3 Following is general guideline for use as basis of sequence when preparing final version for approval from AHJ. Edit as required. Generally, activation of any alarm initiating device in areas causes:
 - .1 System locks into alarm state in accordance with requirements of AHJ.

- .2 Audible devices sound evacuation tone continuously.
- .3 Visual devices illuminate.
- .4 Zone of device in alarm condition register and display on annunciators.
- .5 For addressable systems: Address of device in alarm condition to also register and display on annunciators.
- .6 Activation of circuitry transmitting alarm signal to devices as reviewed with Consultant, sending alarm signal to fire department or to third party protection company.
- .7 Log alarm/trouble events in historical event log.
- .8 Signal to interconnected systems indicating that fire alarm system is activated.
- .9 Initiate elevator emergency as required by sequence of operation.
- .10 Indicate alarm details in remote annunciators.
- .11 Illuminate fire signs at fire alarm zones where they occur.
- .12 Associated integrated low voltage systems signalled, as required by sequence of operations. Exact systems integrated as reviewed with Consultant. Emergency sequencing of other system initiated.
- .13 Release door holders, as required by sequence of operations.
- .4 Resetting device not to return system indications or functions back to normal until control unit reset.
- .5 Trouble on System:
 - .1 Indicates circuit in trouble on control panel.
 - .2 Activates "System Trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition, silencing audible indication. Visual indication remains until trouble cleared and system back to normal.
 - .3 Trouble on system suppressed during course of alarm.
 - .4 Trouble condition on any circuit in system, not to initiate alarm conditions.
- .6 Unauthorized closure of fire protection system piping supervised valve causes location of closed signal (audible and visual) to sound and illuminate, and trouble signal transmitted (via connection) to Fire Department or to outside protection agency.
- .7 Low pressure in fire protection piping mains (wet and dry), fire protection system pumps (fire pumps-standpipe system excess pressure pump-sprinkler pump, sprinkler system excess pressure pump) loss of power, or operation of fire pumps to also activate audible and visual trouble alarm as specified above for supervised alarms.

3.03 INSTALLATION OF CONTROL PANELS AND ANNUNCIATORS

- .1 Install control panels, transponders and remote annunciators in locations. Mount equipment and connect. Arrange for manufacturer authorized technician to program system with reviewed and approved sequence of operation.
- .2 Secure each panel enclosure to walls and connect with fire rated type MI conductors or equivalent fire-rated means reviewed with and recommended for acceptance by Consultant. Coordinate location and installation requirements with trade responsible for wall finishes and review with Consultant.
- .3 Connect panels to dedicated circuit breakers in nearest emergency panel as noted. Verify that room housing panels have fire-rating in accordance with building code requirements.

- .4 Provide passive graphic annunciator in location as noted. Where installed in main entrance vestibule, co-ordinate backbox installation with general trades work of wall structure. Submit annunciator schedule with shop drawings. Prior to installation, review zone nomenclature with Consultant. Before manufacturing, submit proposed drawing and sample of graphic display to Consultant. Obtain approvals from AHJ.
- .5 Ground and bond equipment and components to building ground. Do not use conduit as ground. Provide green coloured grounding loop, minimum #10 AWG insulated copper, run in conduit. Connect ground loop to main building ground system source. Do not run ground wire in same conduit as fire alarm and communication wiring.

3.04 INSTALLATION OF DEVICES

- .1 Install devices, circuit devices and perform work. Obtain training from manufacturer, on special installation requirements.
- .2 Do not install devices in locations that hamper proper operation of devices, including adjacent devices. Set device addresses at time of installation and programming of system.
- .3 Install manual stations in electrical boxes of type suiting device requirements, recessed boxes with plaster rings, unless in unfinished areas where manual stations are surface mounted, in which case, install stations in surface mounted boxes. Comply with mounting height requirements for barrier free access, and as noted.
- .4 Install mounting plate of thermal detectors to ceiling-mounted boxes. Secure detectors to plates. Refer to floor plans and drawing symbol list to determine rating of detectors in areas. Generally, do not install rate-of-rise type detectors in areas subject to sudden changes in temperatures, such as entrance vestibules. Review application requirements with system manufacturer and verify that devices are ULC listed for such applications.
- .5 Secure base of each ceiling-mounted products of combustion detectors to boxes, either flush or surface-mounted suiting intended applications. Secure detector heads to bases.
- .6 Install cross-zoned connection of detectors and remote indicating devices for:
 - .1 Areas of raised floors.
 - .2 Within accessible ceiling spaces.
 - .3 For applications as noted.
- .7 Mount each duct mounted products of combustion detector on duct in question and connect with smoke sampling tubes which extend into duct air stream. Install remote alarm lamp assembly for each duct mounted detector. Wall-mount each lamp assembly on standard 100 mm outlet box as close as possible or practicable to detector. Do not locate detectors within 1 m of duct size increaser, or in decreaser fittings, or in duct elbows. Provide wiring in conduit and extend to connect back to system control unit.
- .8 In applications with hold open devices on doors, activation of smoke detectors tied to hold open devices initiates signal causing release of door, in accordance with NFPA. Where electromagnetic locks are used on doors of egress, provide automatic release of locks upon activation of fire alarm, through connection to auxiliary contact of adjacent manual station. Provide conductors and connections to fire alarm system and to electromagnetic locks.
- .9 Provide CO detectors and mount onto recessed boxes in locations as recommended by system manufacturer, suiting intended applications. Interconnect to other CO detectors in series with required module, sounding integral sounders and to control panel annunciating as trouble signal, in accordance with sequence of operation.

- .10 Provide flame detectors in genset rooms and other oil burning rooms.
- .11 Provide fire alarm devices (flame detectors, smoke detectors, audible/visual devices) in genset enclosures. Refer to drawings for device types. Genset enclosure is constructed with conduits and boxes accommodating these fire alarm devices. Install devices and wiring. Extend wiring from devices to enclosure termination box. Extend from termination box to main building and connect to fire alarm system. Coordinate work with genset enclosure vendor.
- .12 Generally, audible and visual device locations are as indicated, however, determine requirements for additional device quantities and locations based on results of audibility and visibility device coverage site tests. Provide sound detection metering and personnel to make necessary tests. Relocate devices or provide additional devices, providing device coverage performance in accordance with requirements of AHJ and for obtaining approvals.
- .13 For each area, provide audible and visual devices of specific types as reviewed with Consultant. Install speakers and strobes flush and surface-mounted as noted and suiting architectural wall/ceiling types, each with backbox and trim plate suiting intended applications.
- .14 Mount speakers/horns/strobes in stairwells and wire vertically connected to specific zone as approved by AHJ and reviewed with Consultant. Refer to drawing riser and annunciator schedule.
- .15 Provide horns and strobes, flush and surface-mounted as noted, suiting architectural wall/ceiling types, each with backbox and trim plate suiting intended applications.
- .16 Mount exterior speakers and horns with weather sealed gland nut connection at proper dispersion angle.
- .17 Support flush ceiling-mounted speaker backboxes from structure and not suspended ceiling grid or tiles. Connect speakers to taps providing sound levels in accordance with AHJ sound level requirements. Adjust and certify that levels are in accordance with requirements.
- .18 Wire speakers and horns in Class B, 2 wire circuit configurations, terminating in end of line devices. Wire alternate speakers in same circuits with minimum of 2 circuits for each floor.
- .19 Typically, install visual notification appliances 2400 mm above floor or 300 mm below finished ceiling line. Provide visual notification devices in areas subject to high ambient noise levels, such as mechanical equipment rooms, computer equipment rooms, and areas designated for hearing impaired in accordance with building code requirements. Provide minimum 2 circuits for each floor and connect devices in alternating scheme.
- .20 Install amplifiers sized to power additional speakers and include spare capacity as specified.
- .21 Install fire signs in locations as reviewed with Consultant and connect such that activation of fire alarm system illuminates sign and when system resets and alarm silenced, sign de-energizes.
- .22 Install beacon lights in locations and connect.
- .23 Do not load device circuits more than 80% capacity, except where reviewed with and recommended by Consultant.

3.05 REQUIREMENTS FOR INTEGRATED SYSTEMS AND EQUIPMENT

- .1 Provide voltage sensing relays in each phase, line side, of fire pump controller and standpipe system excess pressure pump starters, sensing loss of line voltage. Energize relays from 15 A 1P breakers and with "C" contacts, one for each phase. When one phase voltage drops below 90% of nominal, trouble alarm signals in fire alarm system indicating "Fire Pump Loss of Voltage" or "Standpipe Excess Pressure Pump Loss of Voltage" at each annunciator.
- .2 Provide auxiliary N.O. contact in fire pump controller and connect to fire alarm annunciators, powered from fire alarm system indicating "Fire Pump Running".
- .3 Provide fire alarm system wiring connections to mechanical equipment and other building systems, performing interrelated functions in accordance with sequence of operations. Provide wiring, relays, contacts or contactors between fire alarm system and various equipment achieving automatic or manual control of equipment and performing integrated fire alarm system functions. Provide shunt trip breakers suiting intended applications. Provide fire rated conductors for applications as noted, and for building code applications. Review requirements with Consultant.
- .4 Provision of fire alarm supervisory wiring connections includes but is not limited to following (suiting intended applications):
 - .1 Fire protection system piping supervised valves and flow switches for alarm initiation.
 - .2 Fire protection system piping supervised valves and flow switches for trouble indication.
 - .3 Fire protection piping pressure detectors for loss of pressure trouble indication.
 - .4 Fan equipment starters.
 - .5 Pumps.
 - .6 Dampers.
 - .7 Fire suppression systems.
 - .8 Range hoods and exhaust hoods.
 - .9 Door holders/releases and electromagnetic locks.
 - .10 Telephone system key switch/PBX for connection to offsite central monitoring station.
 - .11 Telephone system key switch/PBX for connection allowing for integrated general paging with voice communication system.
 - .12 Fire pump transfer switch.
 - .13 Security systems.
 - .14 BAS system.
 - .15 Dimming systems initiating emergency operations.
 - .16 Background music systems and sound systems muting in event of emergency paging.
 - .17 Genset control panel for annunciation of "Genset Running", "Failure", "Genset Battery Low Voltage" and "Genset Low Fuel".
 - .18 Central inverter system for emergency lighting.
 - .19 Devices and equipment as noted.
- .5 Provisions for elevators include but not limited to following:

- .1 Minimum 5 dry contacts, one for connections to smoke detectors in lobbies, machine rooms and hoisting, one for connection to smoke detector activated at designated return landing; and others for auxiliary contacts for use as reviewed with Division 14. Include relay type bases for detectors. Increase number of contacts as required and coordinated with elevator trades.
- .2 Conduit and wiring from fire alarm control panel to each elevator.
- .3 Controller: Review exact requirements with Division 14 and provide requirements.

3.06 ADDITIONAL REQUIREMENTS

- .1 Provide system wiring in accordance with requirements of AHJ, electrical codes, system manufacturer recommendations and based on specific applications and consideration of voltage drop.
- .2 Install wiring in conduit except for MI fire-rated type. Perform wiring connections associated with fire alarm system on terminal strips in junction boxes and colour coded. Splices are not permitted. Install wiring colour coding consistent for entire length of each run. When pulling wires into conduit, use lubricant and run wires straight, not twisted or abraded. Neatly secure exposed wires in apparatus enclosures with supports or ties. Clearly identify wiring at each termination point.
- .3 Provide fire-rated MI type conductors for connections to and interconnections between equipment as noted. Install MI type conductors in accordance with manufacturer instructions and as specified.
- .4 Run alarm indicating circuits (speakers, strobes, horns) and alarm receiving circuits (manual stations, detectors) in separate conduits from each other.
- .5 Arrange sprinkler system alarm valve alarm zones separate from manual station, thermal detector and products-of-combustion detector device zones but can be connected together into zones.
- .6 Provide engraved lamicoid identification nameplates for each equipment or wiring housing and secure to front of housing.
- .7 Prior to ordering annunciators, review nomenclature identification with Consultant.
- .8 Install end-of-line resistors to electrically supervise wiring. Generally, locate end-of-line resistors at ceiling lines above manual station location or in equipment rooms, as reviewed with Consultant. Provide isolators in accordance with ULC standards, and label and identify. Do not locate end-of-line resistors and isolators in concealed locations. Generally, install in equipment rooms.
- .9 Refer to drawing riser diagram. Riser drawings are diagrammatic and are not used for determining quantities or lengths. Determine quantities of components from floor plans and in accordance with requirements of AHJ and referenced standards. Determine quantities of circuits based on drawings information, connected devices, requirements of AHJ and referenced standards, and recommendations of system manufacturer.
- .10 Perform training and instructions to end users reviewed with Consultant.

3.07 IDENTIFICATION

- .1 Provide product identification.
- .2 Number wiring with markers intended for such applications. Colour conductors for each part of system in accordance with system equipment manufacturer recommendations.

- .3 Paint conduit couplings red of paint type suiting intended applications, in accordance with requirements of Division 09.
- .4 Nameplates:
 - .1 Provide engraved lamicoid identification nameplates for each equipment or wiring housing and secure to front of housing.
 - .2 Size 4 unless otherwise noted.

3.08 FIELD QUALITY CONTROL

- .1 Manufacturer Authorized Technician Services:
 - .1 Provide technical training and assistance to certified installers of system.
 - .2 Perform onsite inspection, start-up, testing, verification and certification of installed system.
 - .3 Prepare and sign testing and verification reports for submittal to Consultant.
 - .4 Perform onsite training of each user (with provision of user guides) prior to project completion and instruct in operation and maintenances of system.
- .2 Testing Technicians:
 - .1 Registered technicians in good standing with Canadian Fire Alarm Association (CFAA) or be Certified Fire Alarm Electrician (CFAE) with local Electrical Contractors Association as deemed acceptable to Provincial Fire Marshall.
 - .2 Submit with test reports, copies of valid certification of testing company and technicians.
- .3 Submit to Consultant, proposed schedule for testing and verification of system. Notify Consultant and Commissioning Agent minimum 7 working days in advance of testing.
- .4 Arrange for fire alarm system manufacturer technician to inspect, test, verify, commission and certify system components and wiring, individually and as complete system, in accordance with requirements of CAN/ULC-S537 and CAN/ULC-S1001. Work includes but is not limited to verifying following:
 - .1 Type of equipment installed is that designated by Contract Documents.
 - .2 Wiring connections to equipment components show that installer observed ULC and CSA requirements.
 - .3 Equipment installed in accordance manufacturer recommendations, and signaling devices operated or tested verifying operation.
 - .4 Supervisory wiring of equipment connected to supervised circuit is operating and governmental regulations, concerning such supervisory wiring, are in accordance with requirements of AHJ.
 - .5 Sequence of operation is in accordance with specified sequence of operation and approved by AHJ.
 - .6 System and devices are commissioned and operable.
- .5 Additionally, include for following:
 - .1 Verifying that connections to security system and third-party monitoring party are in accordance with CAN/ULC-S561, where building includes such systems.
 - .2 Verifying fire alarm system on zone by zone basis, phase by phase basis in accordance with project phasing, and verify entire system in whole, at completion of installation.

- .3 Testing system battery power supplies and demonstrate compliance with building code and AHJ requirements that battery supplies provide required duration of supervisory power followed by building code required time (or time directed by AHJ) of full load power. Reviewing and performing method of testing in accordance with AHJ, and reviewing with Consultant. Providing sound measurement devices and personnel for testing.
- .4 Testing system audible devices verifying alarm sound levels in areas are in accordance with building code and AHJ requirements. Site adjust tap settings of audible devices to achieve required audibility levels. Test emergency voice communication system, verifying performance is in accordance with Specifications and requirements of AHJ.
- .5 Testing of electromagnetic door locks to verify performance is in accordance with Specifications.
- .6 Full reviewing, testing, and verification of operation of building ventilation and smoke exhaust system and its integrated operation with fire alarm system and various pieces of air handling equipment.
- .7 Coordinating with AHJ to obtain certificates of approvals.
- .6 Integrated Systems Testing Of Fire Protection And Life Safety Systems:
 - .1 Provide integrated testing requirements as specified in Section 26 05 70 – Electrical Testing.
 - .2 Engage Integrated Testing Coordinator as specified in Section 26 05 70 – Electrical Testing.
- .7 Do not use open flame, or smoke for testing, unless otherwise reviewed with and recommended by Consultant.
- .8 Where project work is phased and requires occupancy at various stages, provide system inspection, testing, commissioning, verification and certification after completion of each phase of work, to approval of AHJ. Upon Substantial Performance of the Project Work, include for providing system inspection, testing, commissioning, verification and certification of entire system work.
- .9 Contact and coordinate with AHJ, for inspections. Integrate AHJ inspection requirements with inspection, testing, commissioning, verification and certification work. Obtain AHJ approval and compliance certifications. Submit copies to Consultant.
- .10 Correct failures or deficiencies found in system during testing, witnessed or directed by AHJ, Consultant, or Commissioning Agent. Re-test and re-verify failures and deficiencies until successfully passed.
- .11 Arrange for manufacturers to supply reasonable amounts of technical assistance with respect to changes required to conform to paragraphs above. During periods of inspection, testing, commissioning, verification and certification work, make electricians available to perform correction work and to assist during this Work. Include for presence of trades responsible for integrated components and systems, during inspection, testing, commissioning, verification and certification work.
- .12 Prepare detailed test sheets of tested components. Submit documentation in form in accordance with referenced standards, acceptable to AHJ, and reviewed with Consultant. Submit testing report documents additionally in electronic format, as reviewed with Consultant.

- .13 On completion of inspection, testing, commissioning and verification of system, obtain from testing technician and forward to Consultant, compliance certificate together with detailed inspection reports listing each and every system component, its location in building and its acceptability. Prepare compliance certificate and inspection reports signed by certified testing technician. Signed test reports certify that systems are installed and perform in accordance with Specification.
- .14 Prepare and submit Integrated Testing report in accordance with CAN/ULC-S1001.
- .15 Obtain from system manufacturer and forward to Consultant, certificate of liability insurance. Refer to Divisions 00 and 01 for liability insurance requirements.
- .16 Combine required documentation into reports. Submit to Consultant.

3.09 ACCEPTABLE INDEPENDENT THIRD-PARTY TESTING COMPANIES

- .1 Canadian Fire Protection.
- .2 EPI Fire.

END OF SECTION

1 GENERAL

1.1 DESCRIPTION

1.2 This Section specifies pruning, root girdling and care of wounds.

1.3 RELATED REQUIREMENTS

1.3.1 Section 32 01 90_33 Tree and Shrub Preservation

1.4 MEASUREMENT AND PAYMENT PROCEDURES

1.4.1 Measure tree pruning for payment per tree.

1.5 REFERENCE STANDARDS

1.5.1 Canadian Nursery Landscape Association (CNLA) / Canadian Society of Landscape Architects (CSLA)

1.5.2 Canadian Landscape Standard 2016, First Edition

1.5.3 Canadian Nursery Stock Standard 2017, Ninth Edition

1.5.4 International Society of Arboriculture (ISA)

1.5.5 Ontario Ministry of Agriculture, Food and Rural Affairs

1.5.6 Publication 483-2004, Pruning Ornamentals.

1.6 DEFINITIONS

1.6.1 Crown Cleaning: consists of selective removal of one or more of following items: dead, dying or diseased branches, weak branches and water sprouts.

1.6.2 Crown Thinning: consists of selective removal of branches to increase light penetration, air movement and reduce weight.

1.6.3 Crown Raising: consists of removal of lower tree branches to provide clearance.

1.6.4 Crown Reduction or Crown Shaping: decreases tree height and/or spread.

1.6.5 Vista Pruning: is selective thinning of framework limbs or specific crown areas to improve views.

1.6.6 Crown Restoration: improves structure, form and appearance of trees that have been severely headed or vandalized..

1.7 QUALITY ASSURANCE

1.7.1 Certification: provide certification in compliance with the requirements of International Society of Arboriculture, Canadian Nursery Landscape Association, Landscape Ontario Green for Life (LO).

1.8 WASTE MANAGEMENT AND DISPOSAL

- 1.8.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
- 1.8.2 Place materials defined as hazardous or toxic in designated containers.
- 1.8.3 Dispose of unused disinfectant at official hazardous material collections site approved Contract Administrator.
- 1.8.4 Ensure emptied containers are sealed and stored safely.
- 1.8.5 Divert wood materials from landfill to facility for recycling as directed Contract Administrator.

1.9 TOOL MAINTENANCE

- 1.9.1 Ensure that tools are clean and sharp throughout pruning operation: do not use tools that crush or tear bark.
- 1.9.2 Disinfect tools before each tree is pruned.
- 1.9.3 On diseased plant material disinfect tools before each cut

2 PRODUCTS

2.1 DISINFECTANT

- 2.1.1 20% solution of sodium hypochlorite or 70% solution of ethyl alcohol.

3 EXECUTION

3.1 APPLICATION

- 3.1.1 Manufacturer's instructions: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 GENERAL

- 3.2.1 Prune in accordance with Pruning Ornamentals, and as directed by Certified Arborist (CA). Where discrepancies occur between standard and specifications, specifications govern.
- 3.2.2 Notify immediately Certified Arborist (CA) conditions detrimental to health of plant material or operations.
- 3.2.3 Prune during plant dormant period or after leaves have matured. Avoid pruning during leaf formation, at time of leaf fall, or when seasonal temperature drops below minus 10 degrees C.
- 3.2.4 Prune each species when in full leaf.
- 3.2.5 Retain natural form and shape of plant species.
- 3.2.6 Do not:
 - 1. Flush cut branches.
 - 2. Crush or tear bark.
 - 3. Cut behind branch bark ridge.

4. Damage branch collars.
5. Damage branches to remain.

3.3 PRUNING

- 3.3.1 Remove dead, dying, diseased and weak growth from plant material to provide crown cleaning as designated by Certified Arborist (CA) to promote healthy growth.
- 3.3.2 Remove live branches that:
 1. Interfere with healthy development and structural strength including branches crossed or rubbing more important branches.
 2. Are of weak structure including narrow crotches.
 3. Obstruct development of more important branches.
 4. Are broken.
- 3.3.3 Remove live branches to re-establish natural species form including:
 1. One or more developing leaders.
 2. Multiple growth due to previous topping.
 3. Branches extending outward from natural form.
 4. Undesirable sucker growth.
- 3.3.4 Remove loose branches, twigs and other debris lodged in tree.
- 3.3.5 Remove vines.
- 3.3.6 For branches under 50 mm in diameter:
 1. Locate branch bark ridge and make cuts smooth and flush with outer edge of branch collar to ensure retention of branch collar. Cut target area to bottom of branch collar at angle equal to that formed by line opposite to branch bark ridge.
 2. Make cuts on dead branches smooth and flush with swollen callus collar. Do not injure or remove callus collar.
 3. Do not cut lead branches unless directed by Certified Arborist (CA).
- 3.3.7 For branches greater than 50 mm in diameter:
 1. Make first cut on lower side of branch 305 mm from trunk, one third diameter of branch.
 2. Make second cut on upper side of branch 500 mm from trunk until branch falls off.
 3. Make final cut adjacent to and outside branch collar.
- 3.3.8 Ensure that trunk bark and branch collar are not damaged or torn during limb removal.
 1. Repair areas which are damaged or remove damaged area back to next branch collar.
- 3.3.9 Remove additional growth designated by Certified Arborist (CA).

3.4 ROOT GIRDLING

- 3.4.1 For girdling roots one-quarter size of trunk diameter or larger, V-cut girdling root one-half way through at point where root is crossing.
- 3.4.2 Remove exposed portion of girdling root as directed by Certified Arborist (CA) after cleanly cutting root flush with grade on each side of parent root. Do not injure bark or parent root.

3.5 CARE OF WOUNDS

- 3.5.1 Shape bark around wound to oblong configuration ensuring minimal increase in wound size. Retain peninsulas of existing live bark

3.6 CLEAN-UP

- 3.6.1 Proceed in accordance with Section 01 74 00 - Cleaning.
- 3.6.2 Collect and dispose of (compost/recycle whenever applicable) pruned material daily and remove from site.
- 3.6.3 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.7 CLOSEOUT

- 3.7.1 Submit trees maintenance reports for review by Contract Administrator.

END OF SECTION 31 01 90

1 GENERAL

1.1 DESCRIPTION

- 1.1.1 This Section specifies excavation, backfilling materials, and methods for subgrade materials only.

1.2 MEASUREMENT AND PAYMENT PROCEDURES

- 1.2.1 No extra compensation will be allowed for removing rock or other materials encountered during excavation work or site work, unless reviewed and approved by Consultant.

1.3 REFERENCE STANDARDS

- 1.3.1 Not applicable.

1.4 SUBMITTALS

- 1.4.1 Submit in accordance with Section 01 33 00 – Submittal Procedures and Section 01 78 00 – Close Out Submittals
- 1.4.2 Buried Utilities and Locates: Contact necessary local and regional authorities and agencies to determine the exact locations of utilities. Submit findings of buried services to the Consultant for review prior to beginning any excavation or demolition.
- 1.4.3 Shoring Design: Where required submit temporary excavation shoring design and drawings, stamped by a Professional Engineer licensed to practice in the Province of work.
- 1.4.4 Compaction Test Reports: Submit backfill compaction test results.

1.5 INSPECTIONS AND TESTING

- 1.5.1 Notify Consultant for review of subgrade and all backfilling operations at least 48 hours prior to commencement. Obtain written approval of materials to be used and testing required. Arrange for presence of an independent testing agency, approved by Owner and Consultant, at any activity required by the Consultant to be tested, including compaction.

1.6 WARRANTY

- 1.6.1 General warranty requirements per Section 01 78 00 – Close Out Submittals

2 PRODUCTS

2.1 REUSE OF EXCAVATED FILL

- 2.1.1 Excavated fill may be re-used subject to approval of the Geotechnical Engineer and Consultant. Otherwise, dispose existing fill off site, and supply and place new fill.

2.2 SOIL FILL

- 2.2.1 Clean, natural soil material, free from organic matter, rocks larger than 50mm, foreign or building debris and other deleterious material. Excavated soils may be used for fill, subject to the approval of the Consultant. Otherwise, disposal of existing fill off site, and supply and placement of new soil fill, shall be paid for at the Unit Price quoted.

2.3 GRANULAR FILL

- 2.3.1 Refer to Civil Engineering and Landscape Drawings and specification notes for – Granular Base Courses.

3 EXECUTION

3.1 DEMOLITION, SITE CLEARING AND REMOVALS

- 3.1.1 It is the Contractor's sole responsibility to contact the necessary local and regional authorities and agencies to determine the exact locations of utilities prior to any excavation or demolition.
- 3.1.2 Remove all existing materials as necessary to expose areas for repair. In areas that have an underlying structural elements or waterproofing membrane, remove overburden material by methods which will not damage existing element that are to remain. Ensure that sufficient undamaged existing membrane remains at the edges of areas being repaired to allow for the lapping and proper bonding of the new membrane with the existing membrane.
- 3.1.3 Sawcut around areas of concrete, curbs, asphalt or paving which require removal. Leave a straight, vertical edge where paving is removed for placing new material against it. For sidewalk removals, extend removals to nearest tooled or control joint.
- 3.1.4 Where existing paving is directly on waterproofing, sawcut to within approximately 10mm of the bottom of the paving. Investigate the thickness of the paving before sawcutting and ensure that sawcuts do not go completely through the paving and damage the existing membrane.
- 3.1.5 Clean site of all rubbish and debris, including materials which are not to be stored or re-used.

3.2 EXCAVATIONS

- 3.2.1 Perform excavation as indicated on the Drawings, to the lines, grades, and elevations shown and so that the requirements for formation of embankments can be followed.
- 3.2.2 Do not begin excavation until elevations and measurements of the existing ground surface are recorded and the proposed work is staked out.
- 3.2.3 Make every effort to protect nearby and buried structures and trees during the excavation process. Properly designed shoring systems must be designed by others prior to excavation/demolition operation commencing. Safety to all personnel and any nearby structures is the sole responsibility of the Contractor.
- 3.2.4 Maintain grading so that the site and excavation is well drained at all times.
- 3.2.5 Install temporary drains and drainage ditches to intercept or divert surface water that may affect the work.
- 3.2.6 Store excavated material suitable and approved for backfilling on the site in areas approved by the Consultant.

- 3.2.7 Where excavation is required through the roots of trees which are to remain, follow directions of Landscape Architect and as outlined in landscape drawings and specifications as well as Arborist report. At a minimum excavate by hand, and cut roots with a saw. Seal cuts with tree wound dressing. Where excavation will result in the loss of more than 20% of the root system, obtain instructions from the Consultant before proceeding.
- 3.2.8 Where excavation is required adjacent to curbs which are to remain in place, excavate 1m from curb to maintain soil bearing for curbs.
- 3.2.9 No blasting or other use of explosives will be permitted.
- 3.2.10 Protect bottoms of excavations from frost.
- 3.2.11 If, through neglect or delay on the part of the Contractor, the earth at subgrade elevation becomes unsuitable for the support of the work to be constructed thereon, excavate down to solid earth, and backfill to the required subgrade elevation with plain concrete, or other suitable material as required to meet the Consultant's approval. This work shall be at the Contractor's expense.

3.3 UNAUTHORIZED EXCAVATIONS

- 3.3.1 Whenever the excavation is carried beyond the lines and grade established by the drawings or as approved by the Consultant as part of a change of contract, fill such excavated space with an approved material and in such a manner as to meet soil and compaction requirements. This work shall be at the Contractor's expense.
- 3.3.2 Fill unauthorized excavation beneath structures with plain concrete or flowable fill as determined by the Consultant.

3.4 DEWATERING

- 3.4.1 Bail, pump out or divert water from excavations, from whatever cause, as it accumulates, and until the time proposed works are placed and set.
- 3.4.2 Provide and operate pumps of sufficient number and capacity, including standby units, and all necessary accessories, to keep excavations free of water at all times.
- 3.4.3 Take care to protect all adjacent structures that would be affected by changes in hydrostatic or earth pressures.
- 3.4.4 The Owner is not liable for leakage encountered during this work from existing sewers, watermains, drains, or from other sewers or drains under construction.
- 3.4.5 Provide settling tanks of adequate size for removal of sand and mud, if and when deemed necessary by the Municipality or Consultant.

3.5 BACKFILL

- 3.5.1 Place backfill and consolidate so that no appreciable subsequent settlement will occur.

- 3.5.2 Place backfill in uniform layers not exceeding 200mm in depth when measured loose and thoroughly compact each layer by tamping, sheep's-foot-roller, mechanical vibrators, or by other effective means acceptable to the Consultant. Compact all backfill in all areas to at least 98% of maximum dry density, at optimum moisture content as specified in the local authority Standard Specifications for Construction Controlled Density Method. Compaction by flooding will not be permitted. Do not compact frozen material. Backfill to accommodate the depth of the specified overlying materials
- 3.5.3 Backfill material which, when used in the work, does not accomplish the required compaction shall be rejected.
- 3.5.4 Provide all backfill material free from large lumps, concrete rubble, blue clay, sod, wood, debris, and other extraneous material.
- 3.5.5 Do not operate heavy equipment for spreading and compacting fill and backfill closer to a wall than a distance equal to the height of the fill or backfill to be placed. Use power-driven hand operated equipment against walls and where space limits the use of heavy equipment.
- 3.5.6 For backfilling below landscaped areas, refer to Section 32 11-23.
- 3.5.7 Backfill all excavations around walls and other foundations, etc. after all work has been inspected and approved. Do not place backfill against walls until all supporting slabs are in place and have attained their design strength or as indicated on Drawings. Place material in maximum 200mm layers, loose thickness or as otherwise defined by compaction equipment limitations. Compact each layer to 98% of the maximum dry density, ***as determined by M.T.O. LS-706***, using manually operated vibratory tampers. Minimum weight of vibratory equipment to be 25 kg and maximum face area to be .065 m². Backfill to accommodate the depth of the specified overlying materials.

3.6 PROTECTION OF THE TOP OF THE SUBGRADE

- 3.6.1 Remove all soft and yielding material and material which will not compact when rolled or tamped and replace with suitable material.
- 3.6.2 At all times, maintain the subgrade in such condition that it will drain readily and effectively. In handling materials, tools and equipment, take precautions as needed to protect the subgrade from damage. In no case will vehicles be allowed to travel in a single track. If ruts are formed, reshape and roll subgrade. Until the subgrade has been checked and approved, do not lay sub-base, base, surface course or pavement.

END OF SECTION 31 23 00

1 GENERAL

1.1 DESCRIPTION

- 1.1.1 Covers materials and processes used for preservation of trees and shrubs on sites.

1.2 RELATED REQUIREMENTS

- 1.2.1 Refer to Civil Engineering Drawings
- 1.2.2 Section 32 01 90.23- Pruning
- 1.2.3 Section 32 92 19.13- Mechanical Seeding
- 1.2.4 Section 32 92 19.16- Hydraulic Seeding
- 1.2.5 Section 32 92 23- Sodding

1.3 REFERENCE STANDARDS

- 1.3.1 Canadian Society of Landscape Architects (CSLA)/ Canadian Nursery Landscape Association (CNLA)
 - 1. Canadian Landscape Standard 2016, First Edition
 - 2. Canadian Nursery Stock Standard 2017, Ninth Edition
- 1.3.2 Department of Justice Canada (Jus)
 - 1. Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - 2. Fertilizers Act (R.S. 1985, c. F-10).
 - 3. Fertilizers Regulations (C.R.C., c. 666).
 - 4. Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- 1.3.3 Health Canada - Pest Management Regulatory Agency (PMRA)
 - 1. National Standard for Pesticide Education, Training and Certification in Canada (1995).
- 1.3.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - 1. Safety Data Sheets (SDS).

1.4 DEFINITIONS

- 1.4.1 Mycorrhiza: association between fungus and roots of plants. This symbiosis, enhances plant establishment in newly landscaped and imported soils.

1.5 ADMINISTRATIVE REQUIREMENTS

- 1.5.1 Scheduling:
 - 1. Obtain approval from Contract Administrator of schedule indicating beginning of Work.

1.6 ACTION AND INFORMATION SUBMITALS

- 1.6.1 Provide in accordance with Section 01 33 00- Submittal Procedures.
- 1.6.2 Product Data:
 - 1. Provide manufacturer's instructions, printed product literature and data sheets for tree and shrub preservation materials and include product characteristics, performance criteria, physical size, finish and limitations.
 - 2. Provide monthly written reports on maintenance during warranty period, to Contract Administrator 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.
- 1.6.3 Submit WHMIS Safety Data Sheet (SDS).

1.7 QUALITY ASSURANCE

- 1.7.1 Qualifications: Provide proof of qualifications when requested Contract Administrator.
- 1.7.2 Landscape Contractor: to be a Member in Good Standing of International Society of Arboriculture, Canadian Nursery Landscape Association, Landscape Ontario Green for Life (LO).
- 1.7.3 Landscape Planting Supervisor: Landscape Horticulturist Journeyperson or Landscape Industry Certified Technician with Softscape Installation designation or equivalent.
- 1.7.4 Landscape Maintenance Supervisor: Landscape Horticulturist Journeyperson or Landscape Industry Certified Technician with Ornamental Maintenance designation or equivalent.

1.8 DELIVERY, STORAGE AND HANDLING

- 1.8.1 Deliver, store and handle materials with manufacturer's written instructions.
- 1.8.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- 1.8.3 Storage and Handling Requirements:
- 1.8.4 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- 1.8.5 Store and protect tree and shrub preservation material] from nicks, scratches, and blemishes.
- 1.8.6 Replace defective or damaged materials with new.

1.9 MAINTENANCE DURING WARRANTY PERIOD

- 1.9.1 From time of acceptance by Contract Administrator to end of warranty period, perform following maintenance operations.
- 1.9.2 Water to maintain soil moisture conditions for optimum growth and health of plant material without causing erosion.

- 1.9.3 Apply pesticides in accordance with National Standard for Pesticide Education, Training and Certification in Canada, Federal, Provincial and Municipal regulations as and when required to control insects, fungus and disease. Obtain product approval from Contract Administrator before application.
- 1.9.4 Apply fertilizer in early spring at manufacturer's suggested rate.
- 1.9.5 Remove dead, broken or hazardous branches from plant material. Dispose of debris through alternative disposal, composting, or mulching.

2 PRODUCTS

2.1 MATERIALS

- 2.1.1 Tree Barriers: Metal T-bars with orange plastic safety per detail.

3 EXECUTION

3.1 EXAMINATION

- 3.1.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for tree and shrub preservation installation in accordance with manufacturer's written instructions.
- 3.1.2 Visually inspect substrate in presence of Contract Administrator.
- 3.1.3 Inform Contract Administrator of unacceptable conditions immediately upon discovery.
- 3.1.4 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Contract Administrator.

3.2 IDENTIFICATION AND PROTECTION

- 3.2.1 Identify plants and limits of root systems to be preserved as approved Contract Administrator.
- 3.2.2 Protect plant and root systems from damage, compaction and contamination resulting from construction as approved by Contract Administrator.
- 3.2.3 Ensure no pruning is done inside drip line. If pruning inside drip line is required consult a Certified Arborist (CA) or Registered Consulting Arborist (RCA) or Landscape Horticulturist Journeyperson or Landscape Industry Certified Technician with Ornamental Maintenance designation, or equivalent, as approved by Contract Administrator.

3.3 TRENCHING AND TUNNELING FOR UNDERGROUND SERVICES

- 3.3.1 Perform excavation and backfilling activities per Civil Engineering drawings.
- 3.3.2 Centre line location and limits of trench/tunnel excavation to be approved by Contract Administrator before excavation. Tunnel excavation to extend 2000 mm from edge of trunk on either side. Require a protective layer of bark mulch 100mm in depth applied around the bases of the trees to avoid compaction of surface roots where heavy traffic with construction equipment is anticipated.

- 3.3.3 Excavate manually within zone of root system. Do not sever roots greater than 40 mm diameter except at greater than 500 mm below existing grade. Protect roots and cut roots cleanly with sharp disinfected tools.
- 3.3.4 If air space trenching is used carefully thread piping and conduit through exposed root system minimizing damage to the root systems.
- 3.3.5 Excavate tunnel under centre of tree trunk using methods and equipment approved by Contact Administrator.
- 3.3.6 Keep roots moist by spraying or covering with moist burlap while the roots are exposed during the excavation and before backfilling.
- 3.3.7 Minimum acceptable depth to top of tunnel: 1000 mm.
- 3.3.8 Backfill for tunnel and trench to 85% Standard Proctor Density. Avoid damage to trunk and roots of tree.
- 3.3.9 Complete tunnelling and backfilling at tree within two (2) weeks of beginning Work.

3.4 LOWERING GRADE AROUND EXISTING TREE

- 3.4.1 Start Work in accordance with schedule approved by Contact Administrator.
- 3.4.2 Cut slope not less than 500 mm from tree trunk to new grade level.
- 3.4.3 Excavate to depths as indicated. Protect root zone designated to remain from damage.
- 3.4.4 When severing roots at excavation level, cut roots with clean, sharp tools.
- 3.4.5 Cultivate excavated surface manually to 15mm depth.
- 3.4.6 Prepare homogeneous soil mixture consisting by volume of:
 - 1. 60% excavated soil cleaned of roots, plant matter, stones, debris.
 - 2. 25% coarse, clean sterile sand.
 - 3. 15% organic matter.
 - 4. Grade 2:12:8 fertilizer at rate of 1.5 kg/m³.
- 3.4.7 Place soil mixture over area of excavation to finished grade level. Compact to 85% Standard Proctor Density.
- 3.4.8 Water entire root zone to optimum soil moisture level.
- 3.4.9 Install surface cover of seeding/sodding per drawings in accordance with Section 32 92 19.16- Hydraulic Seeding and 32 92 23- Sodding.

3.5 PRUNING

- 3.5.1 Prune in accordance with Section 32 01 90.23- Pruning. Prune promptly broken or damaged limbs incurred as a result of excavation or construction with proper cuts by a Certified Arborist (CA) or Registered Consulting Arborist (RCA), Landscape Horticulturist Journey person or Landscape Industry Certified Technician with Ornamental Maintenance designation or equivalent.
- 3.5.2 Prune crown to compensate for root loss while maintaining general form and character of plant. Dispose of debris through alternative disposal, composting or mulching.

3.6 ANTI-DESICCANT

- 3.6.1 Apply anti-desiccant to foliage where applicable and as directed by Contact Administrator.

3.7 CLEANING

- 3.7.1 Progress Cleaning: clean in accordance with Section 01 74 00- Cleaning.
- 3.7.2 Leave Work area clean at end of each day.
- 3.7.3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00- Cleaning.
- 3.7.4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19- Waste Management and Disposal.
 - 1. Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION 32 01 90

1 GENERAL

1.1 DESCRIPTION

- 1.1.1 This section specifies requirements for supplying, producing and placing crushed gravel or quarried stone as a granular base to lines, grades and typical cross sections indicated, or as directed by Engineer/Consultant.

1.2 RELATED REQUIREMENTS

- 1.2.1 Section 32 14 13- Precast Concrete Unit Paving

1.3 REFERENCE STANDARDS

- 1.3.1 American Society for Testing and Materials (ASTM)
1. ASTM C 117-95, Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.
 2. ASTM C 131-96, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 3. ASTM C 136-96a, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 4. ASTM D 698-00a, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft³) (600kN-m/m³).
 5. ASTM D 1557-00, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft³) (2,700kN-m/m³).
 6. ASTM D 4318-00, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- 1.3.2 Canadian General Standards Board (CGSB)
1. CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 2. CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.Safety Data Sheets (SDS).

1.4 DELIVERY, STORAGE AND HANDLING

- 1.4.1 Store cement in weathertight bins or silos that provide protection from dampness and easy access for inspection and identification of each shipment.

1.5 WASTE MANAGEMENT AND DISPOSAL

- 1.5.1 Separate and recycle waste materials in accordance with Section 01 74 19 - Waste Management and Disposal.
- 1.5.2 Divert unused granular material from landfill to local quarry facility as approved by Contract Administrator.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Granular base: material in accordance with the following requirements:

1. Crushed stone or gravel.
2. Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2.

3 EXECUTION

3.1 SEQUENCE OF OPERATION

3.1.1 Place granular base after subgrade surface is inspected and approved by Contract Administrator.

3.1.2 Placing

1. Construct granular base to depth and grade in areas indicated.
2. Ensure no frozen material is placed.
3. Place material only on clean unfrozen surface, free from snow and ice.
4. Begin spreading base material on crown line or on high side of one-way slope.
5. Place material using methods which do not lead to segregation or degradation of aggregate.
6. Place material to full width in uniform layers not exceeding 150 mm compacted thickness. Contract Administrator may authorize thicker lifts (layers) if specified compaction can be achieved.
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.

3.1.3 Compaction Equipment

1. Compaction equipment to be capable of obtaining required material densities.
2. Efficiency of equipment not specified to be proved at least as efficient as specified equipment at no extra cost and written approval must be received from Contract Administrator before use.
3. Equipped with device that records hours of actual work, not motor running hours.

3.1.4 Compacting

1. Compact to density not less than 100% corrected maximum dry density in accordance with ASTM D 698 and ASTM D 1557.
2. Shape and roll alternately to obtain smooth, even and uniformly compacted base.
3. Apply water as necessary during compacting to obtain specified density.
4. In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Contract Administrator.
5. Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

3.1.5 Proof rolling

1. For proof rolling use standard roller of 45400 kg gross mass with four pneumatic tires each carrying 11350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm.

2. Obtain approval from Contract Administrator to use non-standard proof rolling equipment.
3. Proof roll at level in granular base as indicated. If use of non-standard proof rolling equipment is approved, Contract Administrator to determine level of proof rolling.
4. Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
5. Where proof rolling reveals areas of defective subgrade:
 1. Remove base, sub-base and subgrade material to depth and extent as directed by Contract Administrator.
 2. Backfill excavated subgrade with common material and compact in accordance with sub-base material and compact per Civil Engineering drawings.
 3. Replace sub-base material and compact per Civil Engineering drawings
 4. Replace base material and compact in accordance with this Section.
 5. Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by Contract Administrator and replace with new materials per Civil Engineering drawings and this section at no extra cost.

3.2 SITE TOLERANCES

- 3.2.1 Finished base surface to be within plus or minus 10 mm of established grade and cross section but not uniformly high or low. Protect plant and root systems from damage, compaction and contamination resulting from construction as approved by Contract Administrator.

3.3 PROTECTION

- 3.3.1 Maintain finished base in condition conforming to this Section until succeeding material is applied or until acceptance by Contract Administrator.

END OF SECTION 32 11 23

1 GENERAL

1.1 DESCRIPTION

- 1.1.1 This Section specifies installation of precast concrete unit pavers by hand or with mechanical equipment, consult Interlocking Concrete Pavement Institute technical bulletin on Mechanical Installation Specification Guide, on prepared structural surface for pedestrian or vehicular traffic, and includes pavers, bedding and joint sand, edge restraints, cleaners and sealers. An interlocking pavement surface is achieved by use of dentated or rectangular shaped pavers and/or a herringbone laying pattern.

1.2 RELATED REQUIREMENTS

- 1.2.1 Section 32 11 23- Aggregate Base Courses

1.3 REFERENCE STANDARDS

- 1.3.1 American Society for Testing and Materials International, (ASTM).
1. ASTM C 136-01, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 2. ASTM C 979-99, Standard Specification for Pigments for Integrally Colored Concrete.
- 1.3.2 Canadian Standards Association (CSA International).
1. CSA A23.1/A23.2-00, Concrete Materials and Methods of Concrete Construction/Method of Test for Concrete.
 2. CSA A179-94, Mortar and Grout for Unit Masonry.
 3. CSA-A231.2-95, Precast Concrete Pavers.
 4. CSA A283-00, Qualification Code for Concrete Testing Laboratories.

1.4 SHOP DRAWINGS

- 1.4.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- 1.4.2 Indicate layout, pattern and relationship of paving joints to fixtures and project formed details.

1.5 ACTIONN AND INFORMATIONAL SUBMITTALS

- 1.5.1 Product Data:
1. Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
 2. Submit following sampling and testing data:
 1. Sieve analysis for gradation of bedding and joint material.
 2. Unit paver sampling and testing.
 3. Evaluation of cleaning compound.
 4. Submit two copies of WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 33 00 - Submittal Procedures. Indicate VOC's:

1. For cleaning and sealing compounds.
- 1.5.2 Samples:
 1. Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 2. Submit full size sample of each type, standard, end, half, size pavers.
- 1.5.3 Manufacturer's Instructions:
 1. Submit manufacturer's installation instructions.

1.6 QUALITY ASSURANCE

- 1.6.1 Qualifications:
 1. Installer: company or person specializing in precast concrete paver installations with 5 years documented experience and approved by manufacturer.
- 1.6.2 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- 1.6.3 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- 1.6.4 Mock-ups:
 1. Construct mock-up in accordance with Section 01 45 00 - Quality Control.
 2. Install 3 x 3 m area mock-up.
 3. Mock-up will be used:
 1. To judge workmanship, substrate preparation, operation of equipment and material application.
 2. To determine surcharge of bedding layer, joint sizes, lines, laying pattern, colour and texture.
 3. Locate where directed.
 4. Allow 24 hours for inspection of mock-up before proceeding with work.
 5. When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may not remain as part of finished work. Remove mock-up and dispose of materials when no longer required and when directed by Contract Administrator.
- 1.6.5 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

1.7 WASTE MANAGEMENT AND DISPOSAL

- 1.7.1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.
- 1.7.2 Fold up metal banding, flatten and place in designated area for recycling.

2 PRODUCTS

2.1 UNIT PAVERS

- 2.1.1 Unit pavers: to CSA-A231.2 and as indicated in detail.
- 2.1.2 Manufactured in moulds, with spacers, suitable for installation and delivered on site in cubes of laying panels, in protective wrapping.
- 2.1.3 Pigment in concrete pavers: to ASTM C 979.

2.2 BEDDING AND JOINT MATERIALS

- 2.2.1 Determine bedding sand hardness as follows:
 - 1. Randomly select single 1.4 kg sample from sand source.
 - 2. Dry sample for 24 hours at 115 degrees C to 121 degrees C.
 - 3. Obtain 3 sub-samples each weighing 0.2 kg by passing original sample several times through riffle box.
 - 4. Carry out seive analysis test on each sub-sample in accordance with CSA 23.2.
- 2.2.2 Remix each sub-sample and place in nominal litre capacity porcelain jar with two (2) 25 mm diameter steel ball bearings weighing 75 +/- 5 g each. Rotate each jar at 50 rpm for six (6) hours. Repeat sieve analysis. Record individual and average sieve analysis.
- 2.2.3 For each sample tested, maximum increase in percentages passing each sieve and maximum individual percent passing is in accordance with table as follows:

Sieve Size	Max. Increase	Maximum
Passing		
0.075mm	2%	2%
0.150 mm	5%	15%
0.300 mm	5%	35%

- 2.2.4 Bedding and joint sand: clean, non-plastic, free from deleterious or foreign matter, natural or manufactured from crushed rock or gravel. Do not use limestone screenings or stone dust.
- 2.2.5 Gradation: to CSA-A23.1, Table 4 - Grading Limits for Fine Aggregate, and CSA A179 as follows:

Sieve	% Passing for	
Designation	Bedding Sand	Joint Sand
10 mm	100	
5 mm	95-100	100
2.5 mm	80-100	95-100
1.25 mm	50-90	60-100
630 microns	25-65	
600 microns		35-80
315 microns	10-35	
300 microns		15-20
160 microns	2-10	
150 microns		2-15

2.3 EDGE RESTRAINTS

- 2.3.1 Edge restraints shall be concrete
- 2.3.2 Structural curb:
 - 1. Concrete flush curb: to Section 32 16 00 Curbs, Gutters and Sidewalks

2.4 CLEANING COMPOUND

- 2.4.1 Clear, organic solvent, designed and recommended by manufacturer for cleaning concrete pavers of contamination encountered.
- 2.4.2 Acid based chemical detergent, designed and recommended by manufacturer for removal of contamination encountered on pavers.

3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- 3.1.1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 STRUCTURAL SURFACE

- 3.2.1 Verify that structural surfaces conform to levels and compaction required for installation of unit pavers. If discrepancies occur, notify Contract Administrator and do not commence work until instructed by Contract Administrator.
- 3.2.2 Verify that top of structural surface (top of base) does not exceed plus or minus 10 mm of grade over 3 m straightedge.
- 3.2.3 Ensure that structural surface is not frozen or standing water is present during installation.

3.3 STRUCTURAL CURBS

- 3.3.1 Verify that structural curbs conform to elevations and alignments required for installation of unit pavers. If discrepancies occur, notify Contract Administrator and do not commence work until instructed by Contract Administrator.

3.4 INSTALLATION OF EDGE RESTRAINTS

- 3.4.1 Install restraints true to grade, in accordance with manufacturer's recommendations.

3.5 PLACING OF BEDDING MATERIAL

- 3.5.1 Ensure bedding material is not saturated or frozen at all times until installation is complete.
- 3.5.2 Spread and screed material on structural surface to achieve 25mm compacted thickness after vibrating pavers in place. Do not use joint sand for bedding sand.

- 3.5.3 Do not disturb screeded material. Do not use bedding material to fill depressions in structural surface.

3.6 INSTALLATION OF UNIT PAVERS

- 3.6.1 Lay pavers to pattern indicated. Joints between pavers: 2 to 5 mm wide, or as recommended by manufacturer.
- 3.6.2 Use appropriate end, edge and corner stones. Saw cut pavers to fit around obstructions and at abutting structures.
- 3.6.3 Installation by mechanical equipment:
1. Prepare installation sequence and obtain approval of sequence Contract Administrator.
 2. Place paver pallets and other materials without exceeding load bearing capacity, or otherwise detrimentally affecting installations.
 3. Run equipment approved for installation only on paving surfaces vibrated in place.
- 3.6.4 Complete installation after placing each 100 square metres or after placing each 5 m width of installation.
- 3.6.5 Inspect pavers and remove chipped, broken or otherwise damaged pavers Contract Administrator if structural performance or aesthetics is adversely compromised.
- 3.6.6 Replace pavers removed without altering layout and structural quality.
1. Use a low amplitude, high frequency plate compactor capable of at least 22 kN centrifugal compaction force to vibrate pavers into bedding sand.
 2. Inspect, remove, and replace chipped, broken and damaged pavers.
 3. Sweep dry joint sand material into joints.
 4. Settle sand by vibrating pavers with plate compactor.
 5. Continue application of joint material and vibrating of pavers until joints are full. Do not vibrate within 1 m of unrestrained edges of pavers
 6. Complete installation to within 1 m of laying face, with sand-filled joints, at completion of each work day.
 7. Sweep off excess joint material when installation is complete.
 8. Proof roll street pavements with at least two passes of a 10 T rubber-tired roller.
 9. Final surface elevations not to exceed plus or minus 10 mm under 3 m long straightedge.
 10. Surface elevation of pavers: 3 to 4 mm above adjacent drainage inlets, concrete collars or channels.
 11. Ensure conformance of final elevations.

3.7 CLEANING

- 3.7.1 Carry out cleaning at times and conditions recommended by manufacturer of cleaning and as directed by Contract Administrator.
- 3.7.2 Remove and dispose of loose, extraneous materials from surfaces to be cleaned.
- 3.7.3 Apply cleaning compounds appropriate for removal of various contaminants encountered in accordance with manufacturer's recommendations.
- 3.7.4 Final surface to be free of contamination.

3.8 FIELD QUALITY CONTROL

- 3.8.1 Retain concrete testing laboratory accredited in accordance with CSA A238.
- 3.8.2 Sample and test in accordance with CSA-A231.2.
- 3.8.3 Do sampling and testing once for each 5,000 square metres of material on site, as directed Contract Administrator.
- 3.8.4 Contract Administrator will select 10 pavers for testing from material on site for each sampling.
- 3.8.5 Submit test results to Contract Administrator for approval of precast concrete pavers.

3.9 CLEANING

- 3.9.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION 32 14 13

1 GENERAL

1.1 DESCRIPTION

- 1.1.1 This Section specifies crushed stone paving for light-weight vehicle use areas, driveways and pedestrian walks. It is not intended to cover roads or running tracks.

1.2 RELATED REQUIREMENTS

- 1.2.1 Section 32 11 23- Aggregate Base Courses

1.3 REFERENCE STANDARDS

1.3.1 ASTM International

- 1. ASTM C 136-06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- 2. ASTM C 117-04, Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
- 3. ASTM D 4318-05, Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- 4. ASTM D 698-07e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³).

1.3.2 Canadian General Standards Board (CGSB)

- 1. CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
- 2. CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
 - shop drawings
 - 1. Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - 2. Indicate layout, pattern and relationship of paving joints to fixtures and project formed details.

1.4 ADMINISTRATIVE REQUIREMENTS

- 1.4.1 Access: allow access to building at all times.
- 1.4.2 Scheduling: co-ordinate paving schedule to minimize interference with normal use of premises.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- 1.5.1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures

1.6 DELIVERY, STORAGE AND HANDLING

- 1.6.1 Store crushed stone as and where directed by Contract Administrator

2 PRODUCTS

2.1 MATERIALS

- 2.1.1 Granular sub-base: in accordance with Section 32 11 23 - Aggregate Base Courses and following requirements:
1. Crushed, pit run or screened stone, gravel or sand consisting of hard durable particles free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
 2. Gradations: within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.1

SPEC NOTE: When choosing Canadian metric sieve standard CAN/CGSB-8.2 edit Table below to produce material intended.

2.1.2 Table

Sieve Designation	% Passing
75 mm	100
4.75 mm	25-85
0.425 mm	5-30
0.075 mm	0-10

2.1.3 Granular base: in accordance with Section 31 05 16 - Aggregate Materials and following requirements:

1. Crushed stone or gravel: hard, durable, angular particles, free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
2. Gradations: within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.1.

2.1.4 Table:

Sieve Designation	% Passing
19 mm	100
12.5 mm	70-100
4.75 mm	40-70
2.00 mm	23-50
0.425 mm	7-25
0.075 mm	3-8

2.1.5 Liquid limit: ASTM D 4318 maximum 25.

1. Plasticity index: ASTM D 4318 maximum 6.
2. Granular topping:
 1. Screenings: hard, durable, crushed stone particles, free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
 2. Gradations: within limits specified when tested to ASTM C 136 and ASTM C 117.

Sieve Designation % Passing

9.5 mm	100
4.75 mm	50-10
2.00 mm	30-65
0.425 mm	10-30
0.075 mm	5-10

3 EXECUTION

3.1 SUBGRADE

- 3.1.1 Ensure subgrade preparation conforms to levels and compaction required, to allow for installation of granular base.

3.2 SUB-BASE

- 3.2.1 Sub-base material compact to 95 % Standard Density in accordance with ASTM D 698.

3.3 GRANULAR BASE

- 3.3.1 Granular sub-base material minimum thickness: 100 mm.
- 3.3.2 Spread and compact granular base material in uniform layers not exceeding 100 mm compacted thickness.
- 3.3.3 Compact to a density of not less than 98% Standard Density in accordance with ASTM D 698.

3.4 EDGING

- 3.4.1 Install edging true to grade, in location, layout and pattern as indicated.

3.5 GRANULAR TOPPING

- 3.5.1 Place granular topping to compacted thickness of 75mm minimum.
- 3.5.2 Place material in uniform layers not to exceed 75 mm compacted thickness.
1. Compact layer to 98% Standard Density in accordance with ASTM D 698.

3.6 FIELD QUALITY CONTROL

- 3.6.1 Inspection and testing of crushed stone paving: carried out by designated testing laboratory.
- 3.6.2 Testing shall be conducted in up to 2 locations identified by Contract Administrator.
- 3.6.3 Costs of tests: paid under Cash Allowance by the Contractor.

3.7 CLEANING

- 3.7.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
- 3.7.2 Leave Work area clean at end of each day.

- 3.7.3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- 3.7.4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Waste Management and Disposal.
- 3.7.5 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.8 PROTECTION

- 3.8.1 Prevent damage to fencing, sidewalks and adjacent property.
 - 1. Repair damages incurred.

END OF SECTION 32 15 40

1 GENERAL

1.1 DESCRIPTION

- 1.1.1 Specifies requirements for constructing cement concrete walks, curbs and gutters. Describes sustainable requirements and materials used. Includes grade preparation, granular base, concrete, tolerances, expansion, contraction and isolation joints, curing, backfill and linseed oil treatment option.

1.2 RELATED REQUIREMENTS

- 1.2.1 Refer to Civil Engineering Drawings
- 1.2.2 Refer to Structural Drawings

1.3 REFERENCE STANDARDS

- 1.3.1 ASTM International
 - 1. ASTM C117-13, Standard Test Method for Materials Finer than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - 2. ASTM C136/C136M-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 3. ASTM C 309 03, Liquid Membrane Forming Compounds for Curing Concrete.
 - 4. ASTM D1751, Standard Specification For Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - 5. ASTM D698-12e2, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft³) (600 kN-m/m³).
- 1.3.2 CSA Group
 - 1. CSA-A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete, Including Update No. 1 2015.
 - 2. CSA B651-2012 Accessible Design for the Built Environment.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- 1.4.1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures
- 1.4.2 Product Data:
- 1.4.3 Submit WHMIS Safety Data Sheet (SDS)
- 1.4.4 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, and limitations.
- 1.4.5 Inform Contract Administrator of proposed source of materials and provide access for sampling minimum 4 weeks prior to commencing work.

1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Waste Management and Disposal:

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

2 PRODUCTS

2.1 MATERIALS

- 2.1.1 Concrete mixes and materials: per structural specifications.
- 2.1.2 Reinforcing steel: per structural specifications.
- 2.1.3 Joint filler and Curing Compound: per structural specifications.
- 2.1.4 Granular base: following requirements:
 1. Type 1, 2 or 3 fill.
 2. Crushed stone or gravel.
 3. Gradations: within limits specified when tested to ASTM C136 and ASTM C117.
- 2.1.5 Non-staining mineral type form release agent: chemically active release agents containing compounds reacting with free lime to provide water-soluble soap.

3 EXCEUTION

3.1 GRADE PREPARATION

- 3.1.1 Do grade preparation work per civil engineering drawings.
- 3.1.2 Construct embankments using excavated material free from organic matter or other objectionable materials.
- 3.1.3 Dispose of surplus and unsuitable excavated material in approved location on site off site.

3.2 GRANULAR BASE

- 3.2.1 Obtain Contract Administrator's approval of subgrade before placing granular base.
- 3.2.2 Place granular base material to lines, widths, and depths as indicated.
- 3.2.3 Compact granular base in maximum 150 mm layers to minimum 95% of maximum density to ASTM D698

3.3 CONCRETE

- 3.3.1 Obtain Contract Administrator's approval of granular base and reinforcing steel prior to placing concrete.
- 3.3.2 Do concrete work per structural drawings.
- 3.3.3 Immediately after floating, give sidewalk surface uniform broom finish to produce regular corrugations not exceeding 2 mm deep, by drawing broom side to side across sidewalk.
- 3.3.4 Provide edging as indicated with 10 mm radius edging tool.

- 3.3.5 Slip-form pavers equipped with string line system for line and grade control may be used if quality of work acceptable Contract Administrator can be demonstrated. Hand finish surfaces when directed Contract Administrator.

3.4 TOLERANCES

- 3.4.1 Finish surfaces to within 3 mm in 3 m as measured with 3 m straightedge placed on surface.

3.5 EXPANSION AND CONTRACTION JOINTS

- 3.5.1 Install tooled transverse contraction joints after floating, when concrete is stiff, but still plastic, at intervals of 2.5 m.
- 3.5.2 Install expansion joints as directed by Contract Administrator.
- 3.5.3 When sidewalk is adjacent to curb, make joints of curb, gutters and sidewalk coincide.

3.6 ISOLATION JOINTS

- 3.6.1 Install isolation joints around manholes and catch basins and along length adjacent to concrete curbs, catch basins, buildings, or permanent structure.
- 3.6.2 Install joint filler in isolation joints per structural drawings as indicated.
- 3.6.3 Seal isolation joints with sealant approved by Contract Administrator.

3.7 CURING

- 3.7.1 Cure concrete by adding moisture continuously in accordance with CSA-A23.1/A23.2 to exposed finished surfaces for at least 1 day after placing, or sealing moisture in by curing compound as directed by Contract Administrator.
- 3.7.2 Where burlap is used for moist curing, place two pre-wetted layers on concrete surface and keep continuously wet during curing period.
- 3.7.3 Apply curing compound evenly to form continuous film, in accordance with manufacturer's requirements.

3.8 BACKFILL

- 3.8.1 Allow concrete to cure for 7 days prior to backfilling.
- 3.8.2 Backfill to designated elevations with material as directed by Contract Administrator.
 - 1. Compact and shape to required contours as directed by Contract Administrator.

3.9 LINSEED OIL TREATMENT

- 3.9.1 Apply two coats of linseed oil mixture uniformly to surfaces of curbs, walks and gutters, after concrete has cured for specified curing time and when surface of concrete is clean and dry.
- 3.9.2 Linseed oil mixture to consist of 50% boiled linseed oil and 50% mineral spirits by volume.
- 3.9.3 Apply treatment when air temperature above 10 degrees C.
- 3.9.4 Apply first coat at 135 mL/m².

3.9.5 Apply second coat at 90 mL/m² when first coat has dried.

3.10 CLEANING

3.10.1 Proceed in accordance with Section 01 74 11 - Cleaning.

3.10.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION 32 16 00

PART 1 – GENERAL

1.1 SECTION INCLUDES

- .1 Supply and installation of galvanized chain link fence, complete with gate, posts set in concrete bases, top rail, fence fabric, and all necessary fittings and accessories.

1.2 RELATED SECTIONS

- .1 Section 03 30 00 – Cast-in-Place Concrete.
- .2 Section 32 92 19 – Topsoil Placement and Finish Grading (if applicable).
- .3 Section 31 23 33 – Excavation and Fill (for fence post setting).

1.3 REFERENCES

- .1 ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- .2 ASTM A392 – Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
- .3 ASTM F567 – Standard Practice for Installation of Chain-Link Fence.
- .4 ASTM F1083 – Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
- .5 CSA G164 – Hot-Dip Galvanizing of Irregularly Shaped Articles.
- .6 CAN/CGSB-138.1 – Chain Link Fence Fabric.
- .7 CAN/CGSB-138.2 – Chain Link Fence Framework.
- .8 OBC – Ontario Building Code, latest edition.
- .9 Applicable local and provincial codes and regulations.

1.4 SUBMITTALS

- .1 Submit product data sheets for fence fabric, posts, rails, fittings, and accessories.
- .2 Shop Drawings:
 - .1 Submit shop drawings showing layout, post spacing, gate locations, and installation details.
 - .2 Submit final assembly drawings in accordance with Section 01 00 10 – General Requirements.

- .3 Design and Indicate concrete support foundations.
- .4 Indicate electric power requirements, installation details, wiring diagrams, security and fire alarm connections.

- .3 Submit certification of compliance with referenced standards.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials in manufacturer's original, unopened packaging.
- .2 Store materials off the ground on blocking or pallets, in a dry, well-ventilated location.
- .3 Protect materials from corrosion and physical damage.

1.6 QUALITY ASSURANCE

- .1 Installation to be carried out by qualified installers with minimum 5 years' experience in fence installation.
- .2 Comply with CAN/CGSB-138 series and ASTM installation practices.
- .3 Mock-up may be requested by Consultant prior to full installation.

PART 2 – PRODUCTS

2.1 MATERIALS

- .1 Fence Fabric:
 - .1 Chain link fence fabric to CAN/CGSB-138.1.
 - .2 9-gauge galvanized steel wire, diamond mesh, 50 mm opening.
 - .3 Height: [Insert height as per project requirements, typically 1800 mm.
 - .4 Galvanized coating to ASTM A392, Class 2 minimum.
- .2 Line and Terminal Posts:
 - .1 Steel pipe to ASTM F1083, galvanized to CSA G164.
 - .2 Line posts: minimum 60.3 mm OD, 3.91 mm wall thickness.
 - .3 Terminal, corner, and gate posts: minimum 88.9 mm OD, 5.49 mm wall thickness.
 - .4 Post length to suit embedment depth and fence height.
- .3 Top Rail:
 - .1 Continuous horizontal rail at top of fence fabric.
 - .2 Steel pipe: 42.2 mm OD, 2.77 mm wall thickness, galvanized.
- .4 Fittings and Accessories:
 - .1 Galvanized steel tie wires, tension bands, and brace bands.

- .2 Tension bar and truss rods as required.
- .3 All fittings to be hot-dip galvanized.
- .5 Concrete for Post Bases:
 - .1 Strength: Minimum 25 MPa at 28 days, air-entrained, as per Section 03 30 00.
 - .2 Diameter: Minimum 250 mm.
 - .3 Depth: Minimum 1200 mm.

2.2 GATES

- .1 Swing Gates:
 - .1 Provide chain link swing gates at locations and of sizes as indicated on drawings.
 - .2 Fabricate gates using welded galvanized steel pipe frame members. Gate frame members to match strength and finish of adjacent fence framework.
 - .3 Frame to be rigid and square, with welded joints and adequate bracing to prevent sag or twist.
 - .4 Chain link mesh to match adjacent fence in type, mesh size, gauge, and finish. Secure mesh to frame with galvanized tension bars and tie wires.
- .2 Hardware:
 - .1 Provide all necessary hardware including:
 - .2 Heavy-duty self-closing hinges with tamper-resistant fasteners.
 - .3 Lockable latch assemblies, operable from both sides, compatible with padlocks.
 - .4 Drop rods for double-leaf gates.
 - .5 Hold-back devices to secure gate in open position.
 - .6 All hardware to be hot-dip galvanized or stainless steel, corrosion-resistant, and suitable for exterior use.
 - .7 Ensure smooth and free operation of gate hardware under all weather conditions.

2.3 FINISH

- .1 All components, including fence, gate frame, mesh, fittings, and hardware, to be hot-dip galvanized to ASTM A123/A123M or ASTM A153/A153M as applicable.

PART 3 – EXECUTION

3.1 EXAMINATION

- .1 Verify site conditions and ensure alignment and grades are acceptable.
- .2 Confirm property boundaries and layout with Consultant prior to installation.

3.2 INSTALLATION - FENCE

- .1 Set posts at maximum 3.0 m centres, unless noted otherwise.

- .2 Excavate post holes to required depth and diameter.
- .3 Place posts plumb and aligned, with concrete encasement as specified.
- .4 Allow concrete to cure a minimum of 48 hours before stretching fabric.
- .5 Install top rail continuously between terminal posts, securely fastened with appropriate fittings.
- .6 Stretch fence fabric taut and attach with tension bars and ties.
- .7 Bottom of fabric to follow ground contour, with maximum 75 mm clearance.
- .8 Cap all open pipe ends with galvanized caps.

3.3 INSTALLATION - GATE

- .1 Install gates plumb, level, and secure for proper operation.
- .2 Align gates with adjacent fence line and ensure consistent clearance from grade and posts.
- .3 Coordinate gate installation with adjacent site work and access control systems as applicable.

3.4 CLEANING AND PROTECTION

- .1 Remove debris and surplus materials from site.
- .2 Protect fence from damage until completion of the Work.
- .3 Repair any damaged galvanizing per ASTM A780.

END OF SECTION

1 General

- 1 Supply and installation of a high speed electrically operated bi-fold gate system.
- 2 All equipment, motors, gate mechanisms and structural supports shall be by a single manufacturer supplier

3 SUBMITTALS

- 1 Shop Drawings:
 - .1 Submit final assembly drawings in accordance with Section 01 00 10 – General Requirements.
 - .2 Design and Indicate concrete support foundations.
 - .3 Indicate electric power requirements, installation details, wiring diagrams, security and fire alarm connections.
- 2 Installation instructions:
 - .1 Submit two copies of manufacturer's written installation instructions.
- 3 Test reports:
 - .1 Drive unit shall bear a label indicating that the gate controller/operator mechanism has been tested certified to UL 325 and CSA C22.2 No. 247 standards for all electrical components.

4 CLOSEOUT SUBMITTALS

- 1 Provide operation and maintenance data for gate for incorporation into manual as part of Closeout Submittals.
- 2 Conduct comprehensive demonstration for maintenance staff on operation and care of system.

5 WARRANTY

- 1 Warranty shall be 1 year on all parts and installation.
- 2 Motors and operator arms shall be warranted for a period of 5 years.

6 QUALITY ASSURANCE

- 1 Installer shall have a minimum of three years' experience installing similar equipment and approved by manufacturer.

2 Products

1 HIGH SPEED ELECTRONIC SECURITY GATE

- 1 Manufacturer shall be a company specializing in the manufacture of automated gate systems.
- 2 Products: The following shall be the basis of this system:
Foldsmart XT, by
Wallace Perimeter Security,

115 Lawson Crescent, Winnipeg, Manitoba Canada, R3P 1A6

T. 866.300.1110 , www.wallaceperimetersecurity.com

Alternate systems or equipment will be considered provided that suitable performance and test data is submitted demonstrating equivalent performance to the specified system.

2 MATERIALS

- 1 Steel sheet: hot dipped galvanized to ASTM A653/A653M, A36 pre galvanized steel.
- 2 Steel sections: to Canadian Equivalent - CAN/CSA-G40.21 Grade G40.21-350W
- 3 Welding materials: to Canadian Equivalent - CSA W59.
- 4 Electrical components: Complete gate system to be UL325 listed and/or CSA C22.2 No.247 and complying with local requirements.
- 5 Power Supply: 115VAC/230VAC – 20 Amp single phase 60 hertz power supply

3 COMPONENTS

- 1 Gate Columns:
 - .1 HSS steel columns, anchored to concrete foundation.
 - .2 Minimum 200 x 200mm square with a wall thickness of 6.3mm.
- 2 Gate System:
 - .1 Dimensions: as per drawings
 - .2 Panels: Welded Wire Mesh as per drawings.
 - .3 Panel Hinges - Double stacked R16 ball bearing at each hinge point with 25mm hex bolt and lock nut.
 - .4 Column hinges -25mm alloy rod end bearing and 25mm SAE 941 graphite impregnated bronze bushings
 - .5 System shall be fully compliant with ASTM F2200 – 05
 - .6 Performance: System shall be capable of fully opening or closing within 8 seconds.
- 3 Safety/Obstruction Devices:
 - .1 Through beam photoelectric transmitter and receiver: Equip each column with 2 built-in photocells at 500mm and 1500mm inches above the base plate. To be mounted within the columns.
 - .2 Provide obstruction loop relay cards for integration of obstruction loops as required.
- 4 Drive Unit:
 - .1 Provide 24VDC drive with printed circuit board - integrated motor control circuitry for controlling electro-mechanical drive system. Drive system to incorporate current sensing resistors and adaptive monitoring software as inherent entrapment protection.
 - .2 All electrical drive components to be enclosed in weather-resistant housing.
 - .3 Dual 0.5HP, 24 VDC motors, 600:1 gear reduction box with synthetic lubricant.
 - .4 Integrated battery back up
 - .5 Emergency override: Provide point for manual opening and closing in case of power failure/malfunction.

- .6 RS232 and USB port for laptop or other computer peripheral connection for diagnostics and programming.
- .7 Provide ports and connections to accommodate owner security system and fire alarm connections and to enable operation via fob readers, transponders or remote activators.

4 **FINISHES**

- 1 Hot dip galvanized finish 0.5 kg/m2 zinc coating to CAN/CSA-G164.

5 **Features**

- 1 Provide anti climb top guard.
- 2 Provide mounting brackets for mounting adjoining fence and pedestrian gate system to columns.

3 **Execution**

1 **INSTALLATION**

- 1 Provision of concrete foundations per shop drawings.
- 2 Install high-speed security gate to manufacturer's written instructions.
- 3 Verify operations and submit certificate of installation to manufacturer upon completion of installation for warranty validation

2 **CLEANING AND MAINTENANCE**

- 1 Perform cleaning and maintenance procedures in strict accordance with manufacturer's written instructions.
- 2 Maintain logbook of repairs and maintenance.

END OF SECTION

1 GENERAL

1.1 DESCRIPTION

- 1.1.1 Includes standard manufactured catalogue items such as waste containers, benches, planters, tables, bike racks and playground equipment.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- 1.2.1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures

1.3 QUALITY ASSURANCE

- 1.3.1 Provide maintenance data for care and cleaning of site furnishings for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 DELIVERY, STORAGE AND HANDLING

- 1.4.1 Deliver, store and handle materials with manufacturer's written instructions.
- 1.4.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- 1.4.3 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 furnishings from nicks, scratches, and blemishes.
 - 3. Replace defective or damaged materials with new.

2 PRODUCTS

2.1 PLANTER

- 2.1.1 Maglin – 400 Series - Model No. MPL-0400-00003

Acceptable Material:

Base: Steel tube frame

Panels: Lasered steel side panels

Dimensions:

Height: 610mm.

Width: 483mm.

Depth: 483mm.

Finish: Powdercoat Colour, E-Coat rust proofing

3 EXECUTION

3.1 EXAMINATION

- 3.1.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for exterior site furnishing installation in accordance with manufacturer's written instructions.
- 3.1.2 Visually inspect substrate in presence Contract Administrator.
- 3.1.3 Inform Contract Administrator of unacceptable conditions immediately upon discovery.
- 3.1.4 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Contract Administrator.

3.2 PREPARATION

- 3.2.1 Locate and protect utility lines.
- 3.2.2 Notify and acquire written acknowledgement from utility authorities before beginning installation Work.

3.3 INSTALLATION

- 3.3.1 Assemble furnishings in accordance with manufacturer's written recommendations.
- 3.3.2 Install furnishing true, plumb, anchored as directed by the manufacturer.
- 3.3.3 Touch-up damaged finishes to approval of Contract Administrator.

3.4 CLEANING

- 3.4.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
- 3.4.2 Leave Work area clean at end of each day.
- 3.4.3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- 3.4.4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
- 3.4.5 Remove recycling containers and bins from site and dispose of materials at appropriate facility. On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.5 PROTECTION

- 3.5.1 Protect installed products and components from damage during construction.
- 3.5.2 Repair damage to adjacent materials caused by site furnishings installation.

END OF SECTION 32 33 00

1 GENERAL

1.1 DESCRIPTION

- 1.1.1 Specifies seed, mulch, slurry preparation and application, and maintenance for hydraulic seeding.

1.2 REFERENCE STANDARDS

- 1.2.1 Canadian Society of Landscape Architects (CSLA) / Canadian Nursery Landscape Association (CNLA)
 - 1. Canadian Landscape Standard 2016, First Edition
 - 2. Canadian Nursery Stock Standard 2017, Ninth Edition

1.3 MEASUREMENT AND PAYMENT

- 1.3.1 Measure hydraulic seeding square metre of actual surface area for:
 - 1. Grass mixture including fertilizer.
 - 2. Areas of blending into existing turf grass will not be measured for payment.
- 1.3.2 Measure maintenance during establishment period and warranty period of areas seeded in m2.
- 1.3.3 Payment for seeding made at unit price bid of actual area surface measurements taken and computed by Contract Administrator.

1.4 ADMINISTRATIVE REQUIREMENTS

- 1.4.1 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 31 19 - Project Meetings.
- 1.4.2 Scheduling:
 - 1. Schedule hydraulic seeding to coincide with preparation of soil surface.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- 1.5.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- 1.5.2 Product Data:
 - 1. Submit manufacturer's instructions, printed product literature and data sheets for seed, mulch, tackifier, fertilizer, liquid soil amendments and micronutrients.
- 1.5.3 Submit WHMIS Safety Data Sheet (SDS) in accordance with Section 02 81 00 - Hazardous Materials.
- 1.5.4 Submit in writing 7 days before work starts:
 - 1. Volume capacity of hydraulic seeder in litres.
 - 2. Amount of material to be used per tank based on volume.
 - 3. Number of tank loads required per hectare to apply specified slurry mixture per hectare.

1.5.5 Samples:

1. Submit 0.5 kg container of each type of fertilizer used.
2. Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
3. Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.

1.6 QUALITY ASSURANCE

1.6.1 Qualifications: Provide proof of qualifications when requested by Contract Administrator.

1.6.2 Contractor Qualifications:

1. Landscape Contractor: to be a Member in Good Standing of International Society of Arboriculture, Canadian Nursery Landscape Association, Landscape Ontario Green for Life (LO).
2. Landscape Planting Supervisor: Landscape Horticulturist Journeyperson or Landscape Industry Certified Technician with Softscape Installation designation or equivalent.
3. Landscape Maintenance Supervisor: Landscape Horticulturist Journeyperson or Landscape Industry Certified Technician with Turf Maintenance designation or equivalent.

1.7 DELIVERY, STORAGE AND HANDLING

1.7.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

1.7.2 Delivery and Acceptance Requirements:

1. Labelled bags of fertilizer identifying mass in kg, mix components and percentages, date of bagging, supplier's name and lot number.
2. Inoculant containers to be tagged with expiry date.

1.7.3 Storage and Handling Requirements:

1. Store fertilizer off ground, indoors and in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
2. Replace defective or damaged materials with new.

1.8 WARRANTY

1.8.1 Contractor hereby warrants that seeding will remain free of defects in accordance with General Conditions CCDC GC 12.3, for 24 months.

1.8.2 End-of-warranty inspection will be conducted by Contract Administrator.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Seed: "Canada pedigreed grade" in accordance with Government of Canada Seeds Act and Regulations.

- 2.1.2 Grass mixture: “Certified”, “Canada No. 1 or 2 Lawn Grass Mixture” in accordance with Government of Canada “Seeds Act” and “Seeds Regulations”.

1. Mixture composition: TRCA Frugal Dry Mix (TRA-SD-1)

15% *Panicum virgatum*.
15% *Sorghastrum nutans*.
15% *Andropogon gerardii*.
3% *Elymus riparius*.
7% *Elymus virginicus*.
11% *Elymus canadensis*.
2% *Elymus trachycaulus*.
2% *Elymus villosus*.
2% *Oenothera biennis*.
2% *Heliopsis helianthoides*.
5% *Rudbeckia hirta*.
10% *Schizachyrium scoparium*.
5% *Asclepias syriaca*.
2% *Penstemon digitalis*.
2% *Pycnanthemum virginianum*.
2% *Monarda fistulosa*.

2. Mixture composition: TRCA Ontario Short Wet Meadow (TRA-SW-5)

2% *Asclepias incarnata*.
4% *Bromus ciliatus*.
4% *Carex bebbii*.
4% *Carex stipata*.
5% *Carex vulpinoidea*.
15% *Elymus riparius*.
15% *Elymus virginicus*.
5% *Glyceria striata*.
2% *Juncus articulatus*.
2% *Juncus balticu*.
2% *Juncus effusus*.
5% *Juncus tenuis*.
2% *Juncus torreyi*.
2% *Liatris spicata*.

- 1% *Lobelia cardinalis*.
- 2% *Lobelia siphilitica*.
- 1% *Mimulus ringens*.
- 3% *Monarda fistulosa*.
- 2% *Oenothera biennis*.
- 2% *Penstemon digitalis*.
- 2% *Physostegia virginiana* ssp. *virginiana*.
- 5% *Rudbeckia hirta*.
- 10% *Scirpus atrovirens*.
- 3% *Verbena hastata*.

2.1.3 Mulch: specially manufactured for use in hydraulic seeding equipment, non-toxic, water activated, green colouring, free of germination and growth inhibiting factors with following properties:

1. Type I mulch:
 1. Made from wood cellulose fibre.
 - i) Organic matter content: 95% plus or minus 0.5%.
 - ii) Value of pH: 6.0.
 - iii) Potential water absorption: 900%.
 2. Tackifier: water soluble vegetable carbohydrate powder.
 3. Water: free of impurities that would inhibit germination and growth.
 4. Fertilizer:
 1. To Canada "Fertilizers Act" and Regulations.
 2. Complete synthetic, slow release with 35% of nitrogen content in water-insoluble form.
 5. Inoculants: inoculant containers to be tagged with expiry date.
 6. Liquid Soil Amendment and Micronutrients: per seed supplier requirements.

3 EXECUTION

3.1 EXAMINATION

- 3.1.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for hydraulic seeding in accordance with manufacturer's written instructions.
- 3.1.2 Visually inspect substrate in presence of Contract Administrator.
- 3.1.3 Inform Contract Administrator of unacceptable conditions immediately upon discovery.
- 3.1.4 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Contract Administrator.

3.2 PROTECTION OF EXISTING CONDITIONS

- 3.2.1 Protect structures, signs, guide rails, fences, plant material, utilities and other surfaces not intended for spray.
- 3.2.2 Immediately remove any material sprayed where not intended as directed by Contract Administrator.

3.3 PREPARATION OF SURFACES

- 3.3.1 Do not perform work under adverse field conditions such as wind speeds over 10 km/h, frozen ground or ground covered with snow, ice or standing water.
- 3.3.2 Fine grade areas to be seeded free of humps and hollows.
- 3.3.3 Ensure areas are free of deleterious and refuse materials.
- 3.3.4 Cultivated areas identified as requiring cultivation to depth of 25 mm.
- 3.3.5 Ensure areas to be seeded are moist to depth of 150 mm before seeding.
- 3.3.6 Obtain Contract Administrator's approval of grade and topsoil depth before starting to seed.

3.4 PREPARATION OF SLURRY

- 3.4.1 Measure quantities of materials by weight or weight-calibrated volume measurement satisfactory Contract Administrator. Supply equipment required for this work.
- 3.4.2 Charge required water into seeder. Add material into hydraulic seeder under agitation. Pulverize mulch and charge slowly into seeder.
- 3.4.3 After materials are in seeder and well mixed, charge tackifier into seeder and mix thoroughly to complete slurry.

3.5 SLURRY APPLICATION

- 3.5.1 Hydraulic seeding equipment:
 - 1. Slurry tank.
 - 2. Agitation system for slurry to be capable of operating during charging of tank and during seeding, consisting of recirculation of slurry and/or mechanical agitation method.
 - 3. Capable of seeding by 50 m hand operated hoses and appropriate nozzles.
 - 4. Tank volume to be certified by certifying authority and identified by authorities "Volume Certification Plate".
- 3.5.2 Slurry mixture to include seed, mulch, tackifier, water, fertilizer, Liquid Soil Amendment/Micronutrients to amounts specified applied per seed supplier requirements per hectare.
- 3.5.3 Apply slurry uniformly, at optimum angle of application for adherence to surfaces and germination of seed.
 - 1. Using correct nozzle for application.
 - 2. Using hoses for surfaces difficult to reach and to control application.
- 3.5.4 Blend application 305 mm into adjacent grass areas or sodded areas to form uniform surfaces.
- 3.5.5 Re-apply where application is not uniform.

- 3.5.6 Remove slurry from items and areas not designated to be sprayed.

3.6 CLEANING

- 3.6.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
- 3.6.2 Leave Work area clean at end of each day.
- 3.6.3 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.
- 3.6.4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- 3.6.5 Clean and reinstate areas affected by Work.
- 3.6.6 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - 1. Remove recycling containers and bins from site and dispose of materials at appropriate facility.
 - 2. Divert unused fertilizer from landfill to official hazardous material collections site approved by Contract Administrator.

3.7 PROTECTION

- 3.7.1 Protect seeded areas from trespass until plants are established.
- 3.7.2 Remove protection devices as directed by Contract Administrator.

3.8 MAINTENANCE DURING ESTABLISHMENT PERIOD

- 3.8.1 Perform following operations from time of seed application until acceptance by Contract Administrator.
- 3.8.2 Grass Mixture:
 - 1. Repair and reseed dead or bare spots to allow establishment of seed before acceptance.
 - 2. Mow grass to 50 mm whenever it reaches height of 70 mm. Remove clippings which will smother grass [as directed by Contract Administrator.
 - 3. Fertilize seeded areas after first cutting 10 weeks after germination provided plants have mature true leaves in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles; water it well.
- 3.8.3 Control weeds by mechanical or chemical means utilizing acceptable integrated pest management practices.

3.9 ACCEPTANCE

- 3.9.1 Seeded areas will be accepted by Contract Administrator provided that:
 - 1. Seeded areas are free of rutted, eroded, bare or dead spots.
 - 2. Areas have been mown at least twice.
 - 3. Areas have been fertilized.

4. Areas seeded in fall will achieve final acceptance in following spring, one month after start of growing season provided acceptance conditions are fulfilled.

3.10 MAINTENANCE DURING WARRANTY PERIOD

- 3.10.1 Perform following operations from time of acceptance until end of warranty period:

1. Repair and reseed dead or bare spots to satisfaction of Contract Administrator.
2. Mow areas seeded, remove clippings that will smother grassed areas, as directed by Contract Administrator, and in accordance with following schedule:

Seed Mixture	Frequency	Height of Cut
TRA-SD-1	Four times per growing season	20cm
TRA-SW-5	Four times per growing season	20cm

3.11 CLOSEOUT ACTIVITIES

- 3.11.1 Submit seeded areas maintenance reports for review by Contract Administrator.

END OF SECTION 32 92 19_16

1 GENERAL

1.1 DESCRIPTION

- 1.1.1 Includes sod, sod placement, preparation and maintenance.

1.2 RELATED REQUIREMENTS

- 1.2.1 Section 32 91 19.13 - Topsoil Placement and Grading

1.3 REFERENCE STANDARDS

- 1.3.1 Canadian Society of Landscape Architects (CSLA) / Canadian Nursery Landscape Association (CNLA)
 - 1. Canadian Landscape Standard 2016, First Edition
 - 2. Canadian Nursery Stock Standard 2017, Ninth Edition

1.4 MEASUREMENT AND PAYMENT

- 1.4.1 Payment for sodding will be made at unit price bid of actual area surface measurements taken and computed by Contract Administrator for:
 - 1. Turf Grass Nursery Sod Type One per square metre.

1.5 ADMINISTRATIVE REQUIREMENTS

- 1.5.1 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 31 19 - Project Meetings.
- 1.5.2 Scheduling:
 - 1. Schedule sod laying and/or seeding to coincide with preparation of soil surface.
 - 2. Schedule sod/seed installation when frost is not present in ground.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- 1.6.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- 1.6.2 Product Data:
 - 1. Submit manufacturer's instructions, printed product literature and data sheets for sod, and fertilizer and include product characteristics, performance criteria, physical size, finish and limitations.
 - 2. Submit WHMIS Safety Data Sheet (SDS).
 - 3. Samples.
 - 1. Submit:
 - i) Sod for each type specified.

- ii) Install approved samples in one (1)m² mock-ups and maintain in accordance with maintenance requirements during establishment period.
- iii) 0.5kg container of each type of fertilizer used.
- 2. Obtain approval of samples by Contract Administrator.
- 4. Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements of seed mix, seed purity, and sod quality.
- 5. Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties of seed mix, seed purity, and sod quality.

1.7 QUALITY ASSURANCE

- 1.7.1 Qualifications: Provide proof of qualifications when requested by Contract Administrator.
- 1.7.2 Contractor Qualifications:
 - 1. Landscape Contractor: to be a Member in Good Standing of International Society of Arboriculture, Canadian Nursery Landscape Association, Landscape Ontario Green for Life (LO).
 - 2. Landscape Sodding Supervisor: Landscape Horticulturist Journeyperson or Landscape Industry Certified Technician with Softscape Installation designation or equivalent.
 - 3. Landscape Maintenance Supervisor: Landscape Horticulturist Journeyperson or Landscape Industry Certified Technician with Turf Maintenance designation or equivalent.

1.8 DELIVERY, STORAGE AND HANDLING

- 1.8.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- 1.8.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- 1.8.3 Storage and Handling Requirements:
 - 1. Store materials in accordance with supplier's recommendations.
 - 2. Replace defective or damaged materials with new.
- 1.8.4 For palletized sod products:
 - 1. Sod shall not be dumped or dropped from vehicle.
 - 2. Provide wind protection measures to protect sod during transportation against wind exposure and to prevent drying.
 - 3. Ensure sod freshness and healthy conditions when they arrive on site.
 - 4. Provide weather protection measures as required to keep sod fresh and moist, if installation is to be delayed.
 - 5. During the growing season, and where feasible, sod should be delivered to the site within 36 hours of harvest, and be installed within 24 hours of delivery.
 - 6. Allow sod to dry sufficiently after becoming water logged to prevent tearing or damage during handling.

1.9 WARRANTY

- 1.9.1 Contractor hereby warrants that seeding will remain free of defects in accordance with General Conditions CCDC GC 12.3, for 24 months.
- 1.9.2 End-of-warranty inspection will be conducted by Contract Administrator.

2 PRODUCTS

2.1 MATERIALS

- 2.1.1 Number One Turf Grass Nursery Sod: sod that has been especially sown and cultivated in nursery fields as turf grass crop.
 - 1. Turf Grass Nursery Sod types:
 - 1. Number One Kentucky Bluegrass Sod - Fescue Sod: Nursery Sod grown solely from seed mixture of cultivars of Kentucky Bluegrass and Chewing Fescue or Creeping Red Fescue, containing not less than 40% Kentucky Bluegrass cultivars and 30% Chewing Fescue or Creeping Red Fescue cultivars.
 - 2. Turf Grass Nursery Sod quality:
 - 1. Not more than 1 broadleaf weed and up to 1% native grasses per 40 m².
 - 2. Density of sod sufficient so that no soil is visible from height of 1500 mm when mown to height of 50 mm.
 - 3. Mowing height limit: 35 to 65 mm.
 - 4. Soil portion of sod: 6 to 15 mm in thickness.
- 2.1.2 Fertilizer:
 - 1. To Canada "Fertilizers Act" and Fertilizers Regulations.
 - 2. Complete, synthetic, slow release with 65% of nitrogen content in water-insoluble form.

3 EXECUTION

3.1 EXAMINATION

- 3.1.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for sod installation in accordance with manufacturer's written instructions.
- 3.1.2 Visually inspect substrate in presence of Contract Administrator.
- 3.1.3 Inform Contract Administrator of unacceptable conditions immediately upon discovery.
- 3.1.4 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Contract Administrator.

3.2 PREPARATION

- 3.2.1 Verify that grades are correct and prepared in accordance with Section 32 91 19.13 - Topsoil Placement and Grading. If discrepancies occur, notify Contract Administrator and commence work when instructed by Contract Administrator.
- 3.2.2 Do not perform work under adverse field conditions such as frozen soil, excessively wet soil or soil covered with snow, ice, or standing water.
- 3.2.3 Fine grade surface free of humps and hollows to smooth, even grade, to contours and elevations indicated, to tolerance of plus or minus 8mm, for Turf Grass Nursery Sod, surface to drain naturally.
- 3.2.4 Remove and dispose of weeds; debris; stones 50 mm in diameter and larger; soil contaminated by oil, gasoline and other deleterious materials; off site in location as directed by Contract Administrator in accordance with Section 01 74 19 - Waste Management and Disposal.

3.3 SOD PLACEMENT

- 3.3.1 Lay sod during active growing season for type of sod. Laying sod during dry, freezing, or over frozen soil is unacceptable.
- 3.3.2 If growing medium surface is dry, it shall be lightly moistened immediately before laying sod.
- 3.3.3 Lay sod flush with adjoining grass areas, paving and top surface of curbs, unless shown otherwise on the drawings.
- 3.3.4 Lay sod within 24 hours of being lifted if air temperature exceeds 20 degrees C.
- 3.3.5 Lay sod sections in rows, joints staggered (a minimum of 25 cm). Butt sections closely without overlapping or leaving gaps between sections. Cut out irregular or thin sections with sharp implements.

3.4 CLEANING

- 3.4.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
- 3.4.2 Leave Work area clean at end of each day.
- 3.4.3 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.
- 3.4.4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- 3.4.5 Clean and reinstate areas affected by Work.
- 3.4.6 Waste Management: separate waste materials for reuse, compost, and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - 1. Remove recycling and compost containers and bins from site and dispose of materials at appropriate facility.
 - 2. Divert unused fertilizer from landfill to official hazardous material collections site approved by Contract Administrator.

3.5 PROTECTION BARRIERS

- 3.5.1 Protect newly sodded areas from deterioration with snow fence on rigid frame as directed by Contract Administrator.

3.5.2 Remove protection two (2) weeks after installation or after inspection as directed by Contract Administrator.

3.5.3 Maintain fencing and protective measures in good conditions until acceptance by Contract Administrator.

3.6 MAINTENANCE DURING ESTABLISHMENT PERIOD

3.6.1 Perform following operations from time of seed application until acceptance by Contract Administrator.

1. Water sodded areas in sufficient quantities and at frequency required to maintain optimum soil moisture condition to depth of 75 to 10 mm.
2. Cut grass to 50 mm when or before it reaching height of 75 mm.
 1. Maintain sodded areas weed free 95%.
 2. Temporary barriers or signage to be maintained where required to protect newly established sod.

3.7 ACCEPTANCE

3.7.1 Turf Grass Nursery Sod areas will be accepted by Contract Administrator provided that:

1. Sodded areas are properly established.
2. Sod is free of bare and dead spots.
3. No surface soil is visible from height of 1500 mm when grass has been cut to height of [50] mm.
4. Sodded areas have been cut minimum 2 times before acceptance.

3.7.2 Areas sodded in fall will be accepted in following spring one month after start of growing season provided acceptance conditions are fulfilled.

3.7.3 When environmental conditions allow, all sodded areas showing shrinkage cracks shall be top-dressed and seeded with a seed mix matching the original.

3.8 MAINTENANCE DURING WARRANTY PERIOD

3.8.1 Perform following operations from time of acceptance until end of warranty period:

1. Water sodded Turf Grass Nursery Sod areas at weekly intervals to obtain optimum soil moisture conditions to depth of 100 mm.
2. Repair and resod dead or bare spots to satisfaction of Contract Administrator.
3. Cut grass and remove clippings that will smother grass as directed by Contract Administrator to height as follows:
 1. Turf Grass Nursery Sod:
 - i) 50mm during normal growing conditions.
 2. Cut grass at 2 week intervals or as directed by Contract Administrator but at intervals so that approximately one third of growth is removed in single cut.
 3. Eliminate weeds by mechanical means to extent acceptable to Contract Administrator.

3.9 CLOSEOUT ACTIVITIES

- 3.9.1 Submit sodded areas maintenance reports for review by Contract Administrator.

END OF SECTION 32 92 23

1 GENERAL

1.1 DESCRIPTION

- 1.1.1 This Section specifies plant material, accessories, mulch, planting, tree support, mulching and maintenance.

1.2 RELATED REQUIREMENTS

- 1.2.1 Refer to Civil Engineering Drawings

1.3 DEFINITIONS

- 1.3.1 Mycorrhiza: Association between fungus and roots of plants. This symbiosis enhances plant establishment in newly landscaped and imported soils.

1.4 REFERENCE STANDARDS

- 1.4.1 National Resources Canada (NRCan):
 - 1. Canada's Plant Hardiness Zones, current edition
- 1.4.2 Canadian Society of Landscape Architects (CSLA) / Canadian Nursery Landscape Association (CNLA)
 - 1. Canadian Landscape Standard 2016, First Edition
 - 2. Canadian Nursery Stock Standard 2017, Ninth Edition
- 1.4.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - 1. Safety Data Sheets (SDS)

1.5 ADMINISTRATIVE REQUIREMENTS

- 1.5.1 Scheduling: obtain approval from Contract Administrator of schedule seven (7) days in advance of shipment of plant material.
- 1.5.2 Schedule to include:
 - 1. Quantity and type of plant material.
 - 2. Shipping dates.
 - 3. Arrival dates on site.
 - 4. Planting dates.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- 1.6.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- 1.6.2 Product Data:

1. Submit manufacturer's instructions, printed product literature and data sheets for trees, shrubs, ground cover, fertilizer, mycorrhiza, anti-desiccant, anchoring equipment, and mulch and include product characteristics, performance criteria, physical size, finish and limitations.

1. Submit WHMIS SDS

1.6.3 Samples:

1. Submit samples of mulch

1.7 DELIVERY, STORAGE AND HANDLING

- 1.7.1 Deliver, store and handle materials with manufacturer's written instructions.

- 1.7.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

1. Protect plant material from frost, excessive heat, wind and sun during delivery.
2. Protect plant material from damage during transportation:
 1. 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. Delivery distance exceeds 30 km or vehicle travels at speeds over 80 km/h, use enclosed vehicle where practical.
 3. Protect foliage and root balls using anti-desiccants and tarpaulins, where use of enclosed vehicle is impractical due to size and weight of plant material.

- 1.7.3 Storage and Handling Requirements:

1. Immediately store and protect plant material which will not be installed within one (1) hour.
 1. Store in accordance with supplier's written recommendations at a storage location approved by Contract Administrator.
2. Protect stored plant material from frost, wind and sun to ensure planting success as follows:
 1. For bare root plant material, preserve moisture around roots by heeling-in or burying roots in topsoil or mulch 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.
3. Store and manage hazardous materials in accordance with manufacturer's written instructions.
4. Packaging Waste Management: Remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

1.8 WARRANTY

- 1.8.1 Contractor hereby warrants that plant material as itemized on plant list will remain free of defects in accordance with General Conditions CCDC GC 12.3, but for 2 full growing season, one time only providing adequate maintenance has been provided.
- 1.8.2 End-of-warranty inspection will be conducted by Contract Administrator.

- 1.8.3 Contract Administrator reserves the right to extend Contractor's warranty responsibilities for an additional one year if, at end of initial warranty period, leaf development and growth is not sufficient to ensure future survival

2 PRODUCTS

2.1 PLANT MATERIAL

- 2.1.1 Type of root preparation, sizing, grading and quality: comply to Canadian Nursery Stock Standard.
1. Source of plant material: grown in Zone 5b in accordance with Plant Hardiness Zones in Canada.
 2. Plant material shall be planted in zone specified as appropriate for its species.
 3. Plant material in location appropriate for its species.
- 2.1.2 Plant material: free of disease, insects, defects or injuries and structurally sound with strong fibrous root system.
- 2.1.3 Trees: with straight trunks, well and characteristically branched for species.
- 2.1.4 Trees larger than 200 mm in caliper: half root pruned during each of two successive growing seasons, the latter at least one growing season before arrival on site.
- 2.1.5 Bare root stock: nursery grown, in dormant stage, not balled and burlapped or container grown.
- 2.1.6 Collected stock: maximum 40 mm in caliper, with well developed crowns and characteristically branched; no more than 40% of overall height may be free of branches.
1. During collection, ensure 10% maximum seed crop (or plants) are collected from healthy population of many individuals, and from several plants of same species.
 2. Leave remainder for natural dispersal and as food for dependent organisms.

2.2 WATER

- 2.2.1 Free of impurities that would inhibit plant growth.

2.3 STAKES

- 2.3.1 Wood, pointed one end, 38 x 38 x 2300 mm.

2.4 GUYING WIRE

- 2.4.1 Type 1: steel, 3 mm wire.
- 2.4.2 Type 2: 1 mm diameter multi-wire steel cable.
- 2.4.3 Type 3: 3 mm diameter multi-wire steel cable.

2.5 CLAMPS

- 2.5.1 U-bolt: galvanized, 13 mm diameter, c/w curved retaining bar and hex nuts.
- 2.5.2 Crimp type.

2.6 ANCHORS

2.6.1 Wood:

1. Type 1: 38 x 38 x 460 mm.
2. Type 2: 38 x 67 x 610 mm.

2.6.2 Drive-in type.

1. Type 1: 13 mm diameter x 75 mm long, aluminum.
2. Type 2: 18 mm diameter x 120 mm long, aluminum.

2.6.3 Screw-in type:

1. Type 1: 100 mm diameter steel dis.

2.7 GUYING COLLAR

2.7.1 Tube: plastic 25 mm diameter, nylon reinforced.

1. Ensure that plastic tube to remain soft and pliable under all weather conditions.

2.8 TRUNK PROTECTION

2.8.1 Tree guard per detail and Contract Administrator approval.

2.8.2 200mm dia. corrugated performed pvc pipe. height 20cm

2.9 MULCH

2.9.1 Wood chip: varying in size from 50 mm to 75 mm and 50 to 20 mm thick, free of bark, small branches and leaves.

2.10 FERTILIZER

2.10.1 Synthetic commercial type as recommended by supplier

1. Ensure new root growth is in contact with mycorrhiza.
2. Use mycorrhiza as recommended by manufacturer's written recommendations.

2.11 ANTI-DESICCANT

2.11.1 Wax-like emulsion.

2.12 FLAGGING TAPE

2.12.1 .Fluorescent colour.

2.13 SOURCE QUALITY CONTROL

2.13.1 Obtain approval from Contract Administrator of plant material before planting.

- 2.13.2 Imported plant material shall be accompanied with necessary permits and import licenses. Conform to Federal, Provincial or Territorial regulations.

3 EXECUTION

3.1 EXAMINATION

- 3.1.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for planting installation in accordance with manufacturer's written instructions.
- 3.1.2 Visually inspect substrate in presence of Contract Administrator.
- 3.1.3 Inform Contract Administrator of unacceptable conditions immediately upon discovery.
- 3.1.4 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Contract Administrator.

3.2 PRE-PLANTING PREPARATION

- 3.2.1 Proceed only after receipt of written acceptability of plant material from Contract Administrator.
- 3.2.2 Remove damaged roots and branches from plant material.
- 3.2.3 Apply anti-desiccant to conifers and deciduous trees in leaf in accordance with manufacturer's instructions.
- 3.2.4 Locate and protect utility lines.
- 3.2.5 Notify and acquire written acknowledgement from utility authorities before beginning excavation of planting pits for trees and shrubs.

3.3 EXCAVATION AND PREPARATION OF PLANTING BEDS

- 3.3.1 Establishment of sub-grade for planting beds Refer to Civil Engineering Drawings.
- 3.3.2 Preparation of planting beds Refer to Civil Engineering Drawings.
- 3.3.3 For individual planting holes:
 - 1. Stake out location and obtain approval from Contract Administrator before excavating.

3.4 PLANTING

- 3.4.1 For bare root stock, place 50 mm backfill soil in bottom of hole.
 - 1. Plant trees and shrubs with roots placed straight out and spread evenly in hole.
- 3.4.2 For jute burlapped root balls, cut away top one third of wrapping and wire basket without damaging root ball.
 - 1. Do not pull burlap or rope from under root ball.
- 3.4.3 For container stock or root balls in non-degradable wrapping, remove entire container or wrapping without damaging root ball.
- 3.4.4 Plant vertically in locations as indicated on Drawings or directed by Contract Administrator.

1. Orient plant material to give best appearance in relation to structure, roads and walks.

3.4.5 For trees and shrubs:

1. Backfill soil in 150 mm lifts.
 1. Tamp each lift to eliminate air pockets.
 2. When two thirds of depth of planting pit has been backfilled, fill remaining space with water.
 3. After water has penetrated into soil, backfill to finish grade.
2. Form watering saucer as indicated on Drawings or directed by Contract Administrator.

3.4.6 For ground covers, backfill soil evenly to finish grade and tamp to eliminate air pockets.

3.4.7 Perform backfilling work Refer to Civil Engineering Drawings.

3.4.8 Water plant material thoroughly.

3.4.9 After soil settlement has occurred, fill with soil to finish grade.

3.5 TRUNK PROTECTION

3.5.1 Install trunk protection on deciduous trees as indicated on Drawings or directed by Contract Administrator.

3.5.2 Install trunk protection before installation of tree supports.

3.6 TREE SUPPORTS

3.6.1 Install tree supports as indicated on Drawings or directed by Contract Administrator.

3.6.2 Use single stake tree support for deciduous trees less than 3m in height and evergreens less than 2m in height.

1. Place stake on prevailing wind side and 150 mm minimum from trunk.
2. Drive stake 150 mm minimum into undisturbed soil beneath roots.
 1. Ensure stake is secure, vertical and unsplit.
3. Install 150 mm long guying collar 1500 mm above grade.
4. Thread Type 1 guying wire through guying collar tube.
 1. Twist wire to form collar and secure firmly to stake. Cut off excess wire.

3.6.3 Use three (3) guy wires and anchors for deciduous trees greater than three (3)m in height, 12 cm caliper and evergreens greater than two (2) m in height.

1. Use Type 2 guying wire with clamps for trees less than 75mm in diameter and Type 3 guying wire with clamps for trees greater than 75mm in diameter.
2. Use Type 1 anchors for trees less than 75mm in diameter and Type 2 anchors for trees greater than 75mm in diameter.
3. Install guying collars above branch to prevent slipping at approximately 2/3 height for evergreens and 1/2 height for deciduous trees. Collar mounting height not to exceed 2.5 m above grade.

4. Guying collars to be of sufficient length to encircle tree plus 50mm space for trunk clearance. Thread guy wire through collar encircling tree trunk and secure to lead wire by clamp or multi-wraps; cut wire ends close to wrap. Spread lead wires equally proportioned about trunk at 120 degrees.
5. Install anchors at equal intervals about tree and away from trunk so guy wire will form 45-degree angle with ground. Install anchor at angle to achieve maximum resistance for guy wire.
6. Attach guy wire to anchors. Tension wire and secure by multi-wraps.
7. Install wire tightener ensuring that guys are secure and leave room for slight movement of tree but do not allow for root system to shift into growing medium.
8. Saw tops off wooden anchors which extend in excess of 100 mm above grade or as directed by Contract Administrator.
9. Install flagging tape to guys as indicated on Drawings or directed by Contract Administrator.
10. After tree supports have been installed, remove broken branches with clean, sharp tools.

3.7 MULCHING

- 3.7.1 Ensure soil settlement has been corrected before mulching.
- 3.7.2 Spread mulch as indicated on Drawings or directed by Contract Administrator.

3.8 MAINTENANCE DURING ESTABLISHMENT PERIOD

- 3.8.1 Perform following maintenance operations from time of planting to acceptance Contract Administrator.
 1. Water to maintain soil moisture conditions for optimum establishment, growth and health of plant material without causing erosion.
 1. Monitor and maintain self watering product during establishment period.
 2. Water evergreen plant material thoroughly in late fall before freeze-up to saturate soil around root system.
 2. Remove weeds monthly.
 3. Replace or re-spread damaged, missing or disturbed mulch.
 4. Cultivate non-mulched areas, as required to keep top layer of soil friable.
 5. Use appropriate control methods if required, to control insects, fungus and disease, in accordance with federal, provincial and municipal regulations. Obtain product approval from Contract Administrator before application.
 6. Remove dead or broken branches from plant material.
 7. Keep trunk protection and guy wires in proper repair and adjustment.
 8. Remove and replace dead plants and plants not in healthy growing condition. Make replacements in same manner as specified for original plantings.

3.9 MAINTENANCE DURING WARRANTY PERIOD

- 3.9.1 From time of acceptance by Contract Administrator to end of warranty period, perform following maintenance operations.

1. Water to maintain soil moisture conditions for optimum growth and health of plant material without causing erosion.
 1. Self watering product to be monitored and maintained during warranty period.
 2. Reform damaged watering saucers.
2. Remove weeds monthly.
3. Replace or re-spread damaged, missing or disturbed mulch.
4. Cultivate non-mulched areas, cultivate monthly to keep top layer of soil friable.
5. Use appropriate control methods, if required to control insects, fungus and disease, in accordance with federal, provincial and municipal regulations. Obtain product approval from Contract Administrator before application.
6. Apply fertilizer in early spring as indicated by soil test.
7. Remove dead, broken or hazardous branches from plant material.
8. Keep trunk protection and tree supports in proper repair and adjustment.
9. Remove trunk protection, tree supports and level watering saucers at end of warranty period.
10. Remove and replace dead plants and plants not in healthy growing condition. Make replacements in same manner as specified for original plantings.

3.10 CLEANING

- 3.10.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
- 3.10.2 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- 3.10.3 Waste Management: Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 1. Divert discarded burlap, wire and plastic plant containers materials from landfill to plastic recycling facility.
 2. Dispose of unused fertilizer at official hazardous material collection site.
 3. Dispose of unused anti-desiccant at official hazardous material collections site.
 4. Divert unused wood and mulch materials from landfill to composting facility.

3.11 CLOSEOUT ACTIVITIES

- 3.11.1 Submit trees, shrubs and other plantings maintenance reports for by Contract Administrator.

END OF SECTION 32 93 10

APPENDIX

A

DOOR HARDWARE & KEY
SPECIFICATIONS FOR THE
CONNOR BUILDING



Door Hardware & Keys

The City of Richmond Hill utilizes Medeco key registry D2817. This keyway is restricted by Medeco to authorized locksmiths and **currently being serviced and supported by Craig Security Inc.** Craig Security Inc. supplies Medeco lock cylinders and cuts and supplies Medeco keys. The City utilizes a five (5) level master - keyed system and intends to incorporate new City facilities and /or renovated facilities with additional locks to the existing system.

The City of Richmond Hill has no intentions to implement a new master key system on a temporary or permanent basis. All door hardware installed which are to receive locks shall be compatible with the City's Medeco key registry D2817 and fall under the City's existing Medeco master key system.

APPENDIX

B

CARD ACCESS SYSTEM SPECIFICATIONS FOR THE CONNOR BUILDING



Card Access System Specifications for the Connor Building.

Access Control Management Software:

Manufacturer: DORMAKABA GROUP

Keyscan Aurora: The City's Keyscan Aurora system is a fully networked card access system and utilizes a central main database server and multiple communication servers. Remote sites use Keyscan Aurora Client software to access the servers.

Access Control Units – ACUs:

CA8500 – 8 Reader Access Control Unit.

CA4500 – 4 Reader Access Control Unit.

CA-250 – Two-Reader Access Control Unit.

EC-2500 – Two Cab Elevator Floor Access Control Unit. (Not Applicable for this project).

EC-1500 – One Cab Elevator Floor Access Control Unit. (Not Applicable for this project).

Networking & Communications:

CIM (Communications Interlink Module)

CIM-Link (Global Network Connectivity Module)

NETCOM2P TCP/IP Plug-on Communication Adaptor



Facility Management

Technical Services Division

Readers

Manufacturer

HID Global Corporation:

Indala 125 KHz Readers

- PX-603 Standard Proximity Reader
- PX-605 Standard Proximity Reader
- PX-K501 Keypad
- 36-bit wireguard output.
- PX key & Proximity Key Tag.

Note:

The City of Richmond Hill acknowledges some of the above readers may have been phased out. The security contractor shall supply the direct replacements.

Electric Strikes

RCI F2164 - Failed Locked or (Approved Equal).

Note:

In some cases, electrified door hardware requires to be interfaced with door operators and sliding doors. Pending on the application, different electrified door hardware and relays may be required.

APPENDIX



C

SURVEILLANCE SYSTEM
SPECIFICATIONS FOR THE
CONNOR BUILDING



Surveillance System Specifications & Standards for the Connor Building

IP Cameras System:

- . 1 This scope includes the installation and deployment of new video management surveillance system software across the City of Richmond Hills existing location LAN network infrastructure to support the following platform.
 - . 1 Video Management System
 - . 1 The Video Management System (VMS) will mainly be comprised of new Exacqvision Technologies and Axis Communications internet protocol video surveillance equipment not limited to archival servers, software, cameras, and mounts.
 - . 2 The scope of this project includes the supply, installation, labour, knowledge, programming, configuration, lifts, to re-cable with conduit where required new high resolution megapixel HD interior and exterior fixed cameras, lenses, enclosures, brackets, and racks.
 - . 3 The scope of the project includes the supply and installation of required new Cat6 cable, network video storage, client licenses and workstation, uninterruptible power supplies, video management software application and Security Contractor knowledge.
 - . 4 The scope of this project does not permit the use of any analog to IP media convertors and/or ethernet extender modules.
 - . 5 The video management system shall consist of new internet protocol (IP) network video storage technology and supporting software. The Security Contractor shall program and configure the new site network video recorders onto the City of Richmond Hills LAN network.
 - . 6 Acceptable Video Management System Manufacturers and Security Contractor Certifications include:



- .1 Exacqvision Technologies
- .2 Exacqvision Certified Enterprise Reseller Security Contractor Status

- .7 Acceptable Camera Manufacturers
 - .1 Axis Communications
 - .2 Installing individual must possess Gold and/or Silver Axis Certified Professional installer certification.

APPENDIX

D

BURGLARY INTRUSION
SYSTEM SPECIFICATIONS
FOR THE CONNOR BUILDING



Burglary/ Intrusion System Specifications for the Connor Building

Intrusion System

Control Panel

Power Series Neo Control Panel HS 2032

- 8 on-board zones
- Expandable to 32 wireless and hardwired zones

Keypads:

Power Series Neo Keypads HS2LCD

- Full Message LCD Hardwired Keypad

Expansion Modules:

8-Hardwired Zone Expander Module HSM2108

- Adds 8 Hardwired zones

Cellular Alarm Communicator

Power Series Neo LTE/ HSPA/ Internet/ Cellular / Dual Path Alarm Communicators

LE2080/TL280LE

Glass break Detectors

DG – 50 Glassbreak Detectors

Motion Detectors PIR

Optex FLX-P-ST

Sirens:

15W – 20W compatible with the Power Series Neo control panel



Door contacts:

Recessed type

APPENDIX

E

ARBORIST REPORT

CITY OF RICHMOND HILL

CONNOR BUILDING, 39 KING ROAD

ARBORIST REPORT





CONNOR BUILDING, 39 KING ROAD ARBORIST REPORT

CITY OF RICHMOND HILL

PROJECT NO.: CA0010351.5022
DATE: MARCH 21, 2025

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REVISION HISTORY

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March 21, 2025	Third Submission			
Prepared by	Reviewed by	Approved by		
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Landscape Designer

March 21, 2025

Date

APPROVED¹ BY *(must be reviewed for technical accuracy prior to approval)*



Sarah Taslimi, MLA, OALA, ISA
Project Manager, Landscape Architect & ISA
Certified Arborist

March 21, 2025

Date

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APPENDICES

A	TREE PRESERVATION TABLES
B	PHOTOS
C	TREE MANAGEMENT PLAN

1 INTRODUCTION

WSP Canada Inc. (WSP) has been retained by the City of Richmond Hill for the detailed design renovation of the existing Connor Building and property at 39 King Road in Richmond Hill, Ontario. The originally constructed fire hall building/office space is to be retrofitted to create a satellite operations yard that will support current and future year-round operational needs in the northern half of the City. As part of the 60% detailed design, WSP Landscape Architects and Arborists have completed an inventory of trees within the study area that could be impacted by the proposed design. Tree Preservation Plans have been prepared in association with this report.

1.1 Study Area

The study area consists of:

- A facility retrofit to the existing Connor Building and its property, on the corner of King Rd. and Yonge St. This includes a building addition, additional parking, equipment and material storage areas, additional fencing and gates, and outdoor staff seating areas. The site is approximately 8091 m² and is fully within the East Humber River flood plain, with an East Humber River tributary running along the northernmost part of the site.
- Trees were inventoried up to 10m beyond the property limit and include:
 - Trees of any size within Toronto and Region Conservation Authority (TRCA) Regulated limits;
 - Trees of any size on City property; and,
 - Trees 20cm and greater on adjacent private property.

Figure 1: Study Area



Note: The study limit is outlined in red. The TRCA Regulated Area limit is shown in a blue hatch and covers the entirety of the site. Image source: TRCA Regulation Mapping tool (2023)

1.1.1 Tree Inventory

- In accordance with City of Richmond Hill, Region of York and TRCA guidelines for vegetation assessments, trees inventoried include:
 - All trees (any size) within the ROW and TRCA Regulated Areas;
 - Trees >10cm on the subject property; and
 - >20cm on adjacent private property that could be impacted by proposed works.
- Trees were assessed for species, quantity, dripline radius, condition, and location. Recommendations are provided for tree protection, tree preservation, and removals based on the proposed site plan and the proposed limits of work.
- This report is to be read in conjunction with:
 - Appendix A: Tree Preservation Tables;
 - Appendix B: Site Photos;
 - Appendix C: Tree Management Plans (TP-1 to TP-3).

2 EXISTING CONDITIONS

The study limit consists of the Connor Building and property located at 39 King Road in Richmond Hill, Ontario, bounded by King Road to the north, and private property to the east and south, and Bostwick Crescent to the west. The tree inventory limit extends beyond the site limits to capture trees that may be impacted by the proposed works. The study area is characterized as General Commercial GC1. An overview of the built form and treed vegetation is described below.

2.1 Built Form

Adjacent and nearby land use includes low-density residential housing, commercial and transportation as the site is situated near the corner of King Rd and Yonge St, and natural areas along the East Humber River and surrounding park areas.

Built form within and adjacent to the alignment includes:

- Major and local roadways including King Rd and Yonge St;
 - Existing Connor Building;
 - Existing sidewalks and curbs;
 - Existing chain link fences and site furniture;
 - Existing paved driveways, pathways, and unit paver patio areas.
-

2.2 Treed Vegetation

Trees throughout the study area are both planted and naturally occurring. Trees are a mixture of young to mature ranging in size from <10 to 120cm DBH. Trees are a mixture of deciduous and coniferous consisting of both native and non-native species. Vegetation composition and size is detailed below by location. Refer to Appendix A for Tree Inventory & Preservation Charts.

2.2.1 Existing Trees

- Mixture of native and non-native trees;
- Primarily deciduous trees with a few coniferous species;
- Tree size ranges from <10 to 120cm DBH;
- Species composition includes:
 - Abundant: Manitoba Maple (*Acer negundo*), Trembling Aspen (*Populus tremuloides*) and Black Pine (*Pinus nigra*);
 - Frequent: Eastern White Cedar (*Thuja occidentalis*), Black walnut (*Juglans nigra*), Scots Pine (*Pinus sylvestris*) and White Willow (*Salix alba* 'Tristis');

- Occasional: Norway maple (*Acer platanoides*), Basswood (*Tilia americana*), Hedge Maple (*Acer campestre*), Blue Ash (*Fraxinus quadrangulate*), Norway Spruce (*Picea abies*), and Lilac (*Syringa vulgaris*);
 - Rare: Hawthorn sp. (*Crataegus sp.*), Siberian Elm (*Ulmus pumila*), Russian Olive (*Elaeagnus angustifolia*), Crab apple sp. (*Malus sp.*), Sweet Cherry (*Prunus sylvestris*).
-

2.3 Condition

Tree health ranges between good and poor, with a majority observed to be in good condition. Signs of decline and defects were observed on some trees including:

- Wound / crack / cavity on trunk;
- Damage from Emerald Ash Borer (EAB);
- Dead branches;
- Lean;
- Exposed and girdling roots;
- Codominant stems;
- Included bark;
- Vines;
- Base sprouting and watersprouts;
- Broken / dead leader;
- Canopy dieback;
- Dying / dead.

3 POLICY CONTEXT

This section summarizes the various municipal, regional, provincial, and federal planning policies and regulations related to the tree inventory and which apply to the project.

3.1 City of Richmond Hill – Tree Preservation By-Law

This By-law (2008-96) prohibits or regulates the protection, destruction or injuring of trees located on public and private property within the City of Richmond Hill. The By-law applies to trees of 20cm or greater within City limits. This does not include trees that are deemed as dead, diseased, or hazardous by an Arborist.

Applicability to Project

- 9 of 92 trees have been deemed as dead, diseased, or hazardous by an Arborist; therefore, this by-law does apply.
-

3.2 Canada Food and Inspection Agency

Canada Food and Inspection Agency (CFIA) Directive D-03-08: Phytosanitary Requirements to Prevent the Introduction into and spread within Canada of the Emerald Ash Borer (EAB), *Agilus planipennis* (Fairmaire) applies to Ash species (*Fraxinus spp.*) observed on properties that are located within the EAB Regulated Areas of Canada, prepared by the CFIA and dated March 2021. This area covers all south and central Ontario and western Quebec. Ash trees that require removal are subject to this directive.

Applicability to Project

- The CFIA restricts the movement of all Ash material including wood, bark, chips or bark chips from being transported outside of the Regulated Area. A Movement Certificate is required by the CFIA for any Ash material leaving the Regulated Area.
 - Ash are permitted to be chipped on site and/or removed or cut down and removed from site. Chipped Ash material that is to remain on site must be ground or chipped to a size of less than 2.5 cm in any two dimensions. All Ash material chipped or whole that is to be removed from site must be disposed of within the Regulated Areas of Canada.
 - Refer to the CFIA website for a current map of the ‘Emerald Ash Borer Regulated Areas of Canada’
 - A total of three Ash trees (*Fraxinus sp.*) were observed within the study limits. Signs of EAB were observed on one of the three trees. DBH. There are 8 trees recommended for removal either due to the proposed works or tree health; therefore, the procedures and guidelines for Ash tree removal will need to be followed.
-

3.3 Toronto and Region Conservation Authority Regulation Limit

The Toronto and Region Conservation Authority (TRCA), as mandated under O. Reg. 166/06 TRCA Regulation of Development, Interference with Wetlands and Alteration to Shorelines and Watercourses, regulates and may prohibit work that may take place within a regulated area (“an area that represents the greatest physical extent of the combined hazards, plus a prescribed allowance, as set out in the

Conservation Authorities Act”). This includes valley and stream corridors, wetlands and associated areas of interference and the Lake Ontario waterfront.

Applicability to Project

- The entirety of the site is within TRCA Regulated Areas (East Humber River flood plain); therefore the proposed works and tree impacts are subject to O.Reg 166/06 and the TRCA guidelines. Refer to Figure 1.

3.4 Migratory Bird Convention Act

- Nesting migratory birds are protected under the Migratory Birds Conservation Act, MBCA (1994) and Regulations.
- No work is permitted to proceed that would result in the destruction of nests or eggs, or the wounding or killing of birds species protected under the MBCA and / or Regulations under that Act. It is the responsibility of the proponent and/or contractor to ensure compliance with the MBCA. Guidance for assessing potential risk of MBCA contravention and other relevant information is found on Environment and Climate Change Canada’s website: <https://www.canada.ca/en/services/environment/wildlife-plants-species/migratory-birds.html>
- To reduce the possibility of contravention of the MBCA, vegetation removal should be scheduled to occur outside of the overall bird nesting season of **March 31 to August 31**. Some birds may nest before and after this peak bird nesting season due to annual seasonal fluctuations. If a nest of a migratory bird is found within the construction area outside of this nesting period, it still receives protection. See nesting period and calendars here: <https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods.html>
- If vegetation must be removed during the overall bird nesting season:
- Nest and nesting activity searches will be conducted in areas defined as simple habitat (i.e., the CUM1-1 community) by a qualified Biologist no more than 24 hours prior to vegetation removal. Nesting activity will be documented when it consists of confirmed breeding evidence, as defined by OBBA criteria (Cadman, 2009).
- If an active nest or confirmed nesting activity of a migratory bird is observed in simple habitat, regardless of the timing window recommended, a species-specific buffer area following ECCC guidelines will be applied to the nest or confirmed nesting activity wherein no vegetation removal will be permitted until the young have fledged from the nest. The radius of the buffer will depend on species, level of disturbance and landscape context (ECCC 2018), which will be confirmed by a qualified Biologist, but will protect a minimum of 10 m around the nest or nesting activity.
- The results of all nest searches will be documented at the end of each survey day in a Technical Memorandum, including information on the searcher, date, time conducted, weather conditions, habitat type, vegetation community type, observations of breeding activity, observations of confirmed nests including co-ordinates, and, if required, the buffer applied to identified breeding/nesting sites.
- If vegetation removal must occur in complex habitats within the above-listed timing windows and absolutely cannot be avoided, the same Best Management Practices (BMPs) such as nest and nesting activity searches described above will be undertaken.

3.5 Bat Habitat Protection

- Trees measuring 25cm DBH or greater, especially those with large cavities have potential for bat habitat and their removal should take place outside of the bat active season, which is from March 15 to November 30 at the time of this report writing.
- The Contractor will be responsible for ensuring they are in compliance with up-to-date guidance issued by the Ministry of Natural Resource and Forestry (MNRF) and the Ministry of Environment, Conservation and Parks (MCEP) at the time that removals take place.

4 FIELDWORK

4.1 Tree Inventory Methodology

A field observation was conducted August 23rd, 2023, within the study limits. Trees were inventoried as per the following criteria:

- Trees were assessed for species, quantity, DBH, dripline radius, and general health condition.
- Tree locations were identified on site and through a more detailed topographic survey.
- Representative photographs were taken, which are on file at WSP. A representative photo page can be found in Appendix B.
- Trees were assessed in accordance with the City of Richmond Hill, and TRCA regulations.

4.1.1 Tree Inventory Results

A total of **±92 trees** were assessed for this report:

- 55 individual trees:
 - 23 trees with alpha-numerical identifiers between T1 and T23;
 - 32 trees with aluminum tags numbered 90 to 599.
- ±37 trees in 7 tree groupings:
 - Grouping numbers between G1 and G7

Table 4.1 – Tree Location

LOCATION	TREE NUMBERS	TOTAL
City / TRCA	T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T14, T15, T16, T18, T19, T20, T21, 90, 482, 483, 484, 485, 486, 487, 488, 489, 496, 498, 500, 572, 573, 576, 577, 578, 579, 580, 586, 588, 589, 590, 591, 592, 594, 595, 596, 598, 599, G1, G2, G3, G4, G5, G6, G7	86
Region	T13	1
Private Owner Property (12960 Yonge St)	T17, T22, T23, 491, 499	5
Total		92

5 DEFINITIONS

The following are the definitions of the assessment categories utilized in our tree assessment:

Table 5.1 – Definitions

TERM / ACRONYM	DEFINITION
Tree Number	This number refers to the number on the on the tree tag or alpha-numeric, alphabetical or tree grouping label listed in Table 1: Tree Inventory and Preservation Charts and labelled on the Tree Preservation Plans (e.g. 142 or A1).
Tree Grouping	A tree grouping is more than one (1) tree located within proximity of other trees with no separation between the canopies.
DBH	This refers to diameter (in centimetres) at breast height and is measured at 1.4 m above the ground for each tree.
Tree Protection Zone	This is the area around a tree that is to be protected through tree protection measures e.g. hoarding. No construction activities are to be undertaken within this zone.
Suppressed	Refers to trees that have their crowns completely overtopped by adjacent trees and received limited to very limited sunlight.
Co-dominant Stem	Stems equal in size and relative importance that make up the overall crown of the tree.
Union	Junction point where two or more stems meet. A 'U' shaped junction indicates a well-formed union. A 'V' shaped junction indicates a weakly formed union, whereas stems grow and increase in girth, weak bark called 'included bark' forms within the junction and stems start to push apart causing vertical cracks and loss of structure.
Compartmentalization	This is a naturally occurring process by which chemical and physical barriers are synthesized to prevent the spread of decay and disease in trees.
Irregular Tree Form	Refers to branches and stems that have formed irregularly often resulting in contorted growth, weak attachments, weakly formed unions and codominant stems. The irregular growth of scaffold (lateral) branches typically leads to damage to other scaffold branches.
Imminently Hazardous Tree	Refers to a destabilized or structurally compromised tree that is in imminent danger of causing damage or injury to life or property.
Injure and Injury	Described as any act that will harm a tree's health, including failure to protect in accordance with standards set by the City's tree protection / preservation policy.
Root Zone	Refers to the subterranean area around the tree measured from the trunk to up to 2 to 3 m beyond the dripline.
Critical Root Zone	The minimum area of the root system necessary to maintain vitality or stability of the tree. Typically, this area extends to the dripline of the tree. The severing of one root can cause approximately 5-20% loss of the root system. A reduction of this area by greater than 30% can pose stability concerns for the tree.

Table 5.2 – Tree Assessment Criteria

TERM	DEFINITION
Trunk Integrity (T.I.)	This is an assessment of the trunk for any defects or weaknesses. It is measured on a scale of poor, fair, good.
Canopy Structure (C.S.)	This is an assessment of the scaffold branches, unions and the canopy of the tree. This is measured on a scale of poor, fair, good.
Canopy Vigour (C.V.)	This is an assessment of the health of the tree and assesses the amount of deadwood and live growth in the crown as compared to a 100% healthy tree. The size, colour and amount of foliage are also considered in this category. This is measured on a scale of poor, fair, good.
Good	Tree displays less than 15% deficiency/defect within the given tree assessment criteria (TI, CS, CV).
Fair	Tree displays 15%-40% deficiency/defect within the given tree assessment criteria (TI, CS, CV).
Poor	Tree displays greater than 40% deficiency/defect within the given tree assessment criteria (TI, CS, CV).

6 DISCUSSION

This section is a discussion of the retention potential, preservation/mitigation strategies and impacts to trees within the limits of the proposed design. All tree impacts are subject to review by the City of Richmond Hill and approval through the submission process.

6.1 Proposed Works

The anticipated proposed works are at a 60% design stage and are expected to include:

- Parking: 9 staff/visitors outside fenced compound;
 - Parking inside fenced compound (1 accessible; 9 trucks).
 - Designated snow piling areas;
 - Outdoor seating area for staff;
 - Heated shed;
 - Four covered bin areas;
 - Covered waste bin area;
 - Access to new overhead access door at front of building;
 - Optional outdoor storage area for seasonal dome or garage bay extension at rear of building;
 - Outdoor emergency power generator
-

6.2 Tree Recommendations / Assumptions

The design, infrastructure installation and replacement works have been proposed as part of detailed design drawings prepared by WSP. The site plan elements, including the working area limits have been illustrated on the Tree Preservation Plans.

The following recommendations / assumptions apply to trees that are to be removed, injured, preserved, retained and or transplanted.

6.2.1 Tree Removal

- Tree removal is recommended when the amount of impact is likely to cause a significant and irreversible decline in the health of the tree;
- Tree removal is based on the degree of excavation / disturbance within the TPZ and considers tree species, size, condition and the number of critical roots that would be impacted that are vital to sustaining the trees overall health and stability;
- This designation may also be applied to trees that are dead; in poor condition or trees that could pose future safety concerns; and trees dying because of a disease or insect infestation.

6.2.2 Tree Protection Zone Encroachment

- Where proposed works related to the site design will encroach into a Tree Protection Zone (TPZ), a reduction will be required resulting in potential tree injury;
 - Where reductions are moderate to significant, mitigative measures may be recommended to minimize damage to roots and canopy (e.g. root pruning, hydro-vacuum excavation).
-

6.2.3 Tree Preservation

- Preservation of trees is considered where an encroachment, excavation or disturbance into the TPZ is expected to be minor or nil and that tree health and stability will not be adversely impacted;
 - The implementation of mitigation measures will reduce potential impacts to the tree therefore allowing for the tree to be preserved.
-

6.2.4 Tree Retention

- Proposed works will occur beyond the TPZ and the dripline with no impacts to the tree. Trees can be retained and do not require tree protection hoarding.
-

6.3 Tree Removals - Construction

Impacts to trees will occur where trees are located within the limits of work for the proposed building upgrades, design features and grading.

- A total of **approximately 41 trees** require removal due to the installation upgraded parking areas, renovated patio, potential garage extension and future driveway as well as demolition of existing infrastructure.
- It should be noted, tree removals within groupings are approximate. An over-estimation approach was taken to ensure all removals would be captured.

Refer to tables 6.1 and 6.2 which detail removals by by-law, tree number, species, size, encroachment, reason for removal and quantity.

Table 6.1 – Tree Removal Table – Construction

TREE ID	SPECIES	SIZE (DBH)	QTY	REASON
T1	<i>Acer platanoides</i> (Norway Maple)	30	1	Within construction limits
G1	<i>Acer platanoides</i> (Norway Maple)	17, 20, 9, 9, 10, 12	6	Within construction limits
T7	<i>Picea abies</i> (Norway Spruce)	45	1	Within construction limits
T8	<i>Salix alba</i> 'Tristis' (White Willow)	75	1	Within construction limits
T15	<i>Malus</i> , Sp. (Crab Apple)	45,15	1	Within construction limits

TREE ID	SPECIES	SIZE (DBH)	QTY	REASON
T19	<i>Pinus nigra</i> (Black Pine)	35	1	Within construction limits
G5	<i>Thuja occidentalis</i> , <i>Syringa vulgaris</i> (Eastern White Cedar, Lilac)	5-20	5	Within construction limits
589	<i>Pinus sylvestris</i> (Scots Pine)	30	1	Within construction limits
599	<i>Thuja occidentalis</i> (Eastern White Cedar)	15	1	Within construction limits
90	<i>Pinus nigra</i> (Black Pine)	40	1	Within construction limits
500	<i>Pinus nigra</i> (Black Pine)	35	1	Within construction limits
498	<i>Crataegus</i> , <i>Sp.</i> (Hawthron)	5-12	1	Within construction limits
496	<i>Pinus sylvestris</i> (Scots Pine)	22	1	Within construction limits
G6	<i>Thuja occidentalis</i> (Eastern White Cedar)	14-17	4	Within construction limits
482	<i>Juglans nigra</i> (Black Walnut)	20	1	Within construction limits
483	<i>Juglans nigra</i> (Black Walnut)	15	1	Within construction limits
487	<i>Acer platanoides</i> (Norway maple)	45	1	Within construction limits
488	<i>Acer platanoides</i> (Norway maple)	60	1	Within construction limits
489	<i>Pinus sylvestris</i> (Scots Pine)	15	1	Within construction limits
G7	<i>Acer negundo</i> (Manitoba Maple)	10-30	2	Within construction limits
T18	<i>Pinus nigra</i> (Black Pine)	27	1	Within construction limits
T19	<i>Pinus nigra</i> (Black Pine)	35	1	Within construction limits
T20	<i>Pinus nigra</i> (Black Pine)	40	1	Within construction limits
T21	<i>Thuja occidentalis</i> (Eastern White Cedar)	15	1	Within construction limits
573	<i>Salix alba</i> 'Tristis' (White Willow)	100	1	Within construction limits
595	<i>Pinus nigra</i> (Black Pine)	40	1	Within construction limits
596	<i>Picea abies</i> (Norway Spruce)	50	1	Within construction limits

Table 6.2 – Tree Removal Summary Table – Construction

LOCATION	TREE NUMBERS	QUANTITY
City / TRCA	T1, G1, T7, T8, T15, T18, T19, T20, T21, G5, G7, 589, 599, 90, 500, 498, 496, G6, 482, 483, 487, 488, 489, 573, 595, 596	40
Total		40

6.4 Tree Removals - Health

Trees that have been assessed in ‘poor’ condition or ‘dead’, are recommended to be removed based on condition only and the potential to become a ‘hazard’. Removal is not related to construction activities.

- There are **9 trees** that have been recommended to be removed due to health.
- Removal of trees in poor condition or dead are subject to review by City of Richmond Hill Urban Forestry.

Table 6.3 – Tree Removal Table – Health

TREE ID	SPECIES	SIZE (DBH)	QTY	CONDITION
577	<i>Acer campestre</i> (Hedge Maple)	20, 15, 14	1	Poor (Large split and broken main leader, heavy dieback)
T3	<i>Fraxinus quadrangulata</i> (Blue Ash)	50	1	Poor (Heavy dieback, evidence of EAB)
T23	-	-	1	Dead, Consent Needed – Noted as Retain and Monitor on plans until Owner consent is obtained
484	-	-	1	Dead
485	-	-	1	Dead
486	-	-	1	Dead
586	-	-	1	Dead
T16	Malus sp. (Crabapple)	5-15	1	Poor (Crowded by Buckthorn, heavy dieback)
491	<i>Acer negundo</i> (Manitoba Maple)	16	1	Poor (Lean, trunk split, mushrooms at base, heavy dieback), Consent Needed, Noted as retain and monitor on plans until Owner consent is obtained

Table 6.4 – Tree Removal Summary Table – Heath

LOCATION	TREE NUMBERS	QUANTITY
City / TRCA	577, T3, 484, 485, 486, 586, T16	7
Private Owner Property (12960 Yonge St)	T23, 491 (Property owner consent required)	2
Total		9

6.5 Tree Protection Zone Reduction (Injury)

The limit of grading has the potential to encroach into and require a reduction of the TPZs of some trees resulting in tree injury.

- Reductions of tree protection hoarding will be required for a total of **5 trees** due to the limit of work and anticipated grading. Root damage may occur dependant upon the proximity of the proposed works;
- Any roots or branches encountered are to be pruned in accordance with the recommendations in Section 10.2 and 10.3. Mitigation measures are recommended where reductions will be significant, however do not warrant the removal of trees;
- Refer to Section 7.1 for mitigation measures that are to be applied for Table 6.5.

Table 6.5 – TPZ Reduction / Encroachment Table – Construction

LOCATION	TREE NUMBERS	QUANTITY
City / TRCA	T6, T10, T11, 590	4
Private Owner Property (12960 Yonge St)	499	1
Total		5

6.6 Tree Pruning

To facilitate the anticipated proposed works, some selective pruning may be necessary, specifically where low-hanging branches overhang the work area. Trees identified for pruning have a dripline that extends over the work area and branches at a height that would interfere with construction operations. Pruning is to be undertaken by a Certified Arborist using proper arboricultural techniques and guidelines in this report prior to the start of construction. This includes trees identified as ‘injured’ and ‘tree protection encroachments’ (Section 6.5).

Pruning will be dependant on the location of the existing tree, canopy size, location of the proposed works and the equipment used during construction. It is to be noted that the contractor is to adjust the size of the equipment where feasible to accommodate low hanging trees or congested areas.

- Based on the criteria above, pruning may be required for several trees to allow for construction.
- Selective pruning will be determined and confirmed on site by the contractor prior to construction.

6.7 Tree Preservation

Trees that are well beyond construction limits with no encroachment into the TPZ can be retained. These trees will not require tree protection hoarding. Trees where construction limits will either encroach into the tree protection zone or will be within close proximity of the TPZ and / or dripline, will require tree protection hoarding. The following Tables provide details on tree protection for City of Richmond Hill trees:

- Table 6.7 details the minimum required TPZs for trees on City of Richmond Hill;
- Table 6.8 details trees by category (retain or preserve), location and tree ID. Refer to Appendix A for minimum TPZ distances for trees.

Table 6.6 – Minimum Tree Protection Zone (TPZ) Determination – City of Richmond Hill

TRUNK DIAMETER	MINIMUM PROTECTION DISTANCES REQUIRED (PUBLIC AND PRIVATE TREES)
<10cm	1.8m
11 to 40cm	2.4m
41 to 50cm	3.0m
51 to 60cm	3.6m
61 to 70cm	4.2m
71 to 80cm	4.8m
81 to 90cm	5.4m
91 to 100cm	6.0m

*The Corporation of the City of Richmond Hill (2021). Application for a Permit to Injure or Destroy

(a)Tree(s) on Private Property

Table 6.8 – Tree Preservation Table

LOCATION	TREE IDS	MIN. TPZ	QUANTITY
City / TRCA	579, 578, T2, 576, T4, T5, T6, T12, G2, T14, G3, G4, 588, 592, 591, 590, 594	2.4	33
	580	3.6	1
	572	5.4	1
	T9, T10, T11	6.0	3
Region	T13	2.4	1

LOCATION	TREE IDS	MIN. TPZ	QUANTITY
Private Owner Property (12960 Yonge St)	T17, T22, 499	3.0	3
Total			43

6.7.1 Hoarding

Tree protective hoarding is to be installed for all trees beyond the work limits listed above under 'Preserve' and per the minimum TPZ distance. This includes a total of **43 trees**. To protect these trees, install the following fence types:

- 1.8m construction fence (e.g. by Fast Fence Inc.) will be erected along the work and will act as tree protection fencing.
- Silt sock (e.g. SiltSoxx by Filtrexx) will be installed outside of the construction fencing where steep slopes are present as sediment control for vegetation and water courses down slope. Refer to Tree Preservation Plans for Silt sock locations.

Hoarding Notes:

- Tree Protection hoarding is to be installed to minimize the impact on the trees to be preserved prior construction and is to remain until the construction is completed (applicable to Private and Public trees) as per By-Law (41-07);
- No construction activity, grade changes, surface treatment or excavations of any kind is permitted within the Tree Protection Zone;
- Tree protection and preservation methods must be followed according to City of Richmond Hill By-law (41-07) and *Application for a Permit to Injure or Destroy (a)Tree(s) on Private Property* (2021);
- Tree protection shall be installed as outlined in the arborist report prior to the commencement of any construction/demolition activities;
- Hoarding inspection shall be conducted by forestry staff prior to any construction/demolition activities;
- The tree protection barriers shall be installed at the approved location and shall be maintained in their original location and condition until all construction activities within the site have ceased and all equipment is removed from the site. No equipment or material storage, flushing of fuel or washing of equipment is allowed within the TPZ. Any works within the TPZ area to be performed or supervised by a Certified Arborist.

7 MITIGATION MEASURES

Mitigation measures are recommended to reduce the amount of impact within the root zone of trees. These measures may include:

- Any roots exposed during grading are to be pruned using good arboricultural practices and per the guidelines in this report;
- To minimize damage to roots it is recommended that excavators scrape soil within the same direction of the roots and not across. Any roots exposed are too be pruned neatly and cleanly.
- Areas where excavation, grading and construction have compacted soil within a reduced TPZ, at the completion of construction, scarify soil to a depth of 100mm. Restore disturbed areas and apply the following methods below;
 - Water trees periodically during construction;
 - After construction it is recommended that a 75mm depth layer of mulch be placed in a 2m radius around the trunks of these trees.

7.1 Air Spade / Hydro Vacuum Excavation

Air-spade / hydro-vacuum excavation has not been recommended as access for equipment would be difficult. If these recommendations change the following methods may be applied:

- Install tree protection hoarding as shown on the Tree Preservation Plans;
- At the limit of the excavation, along the edge of the tree protection fencing, air-spade / hydro-vacuum excavate to a depth of 300mm and at a width of 0.5m to expose roots so they can be pruned;
- Air spade / hydro-vacuum excavation on the outside of tree protection hoarding;
- Ensure that the pressure used from the air spade / hydro-vacuum is such that it will not damage roots during excavation;
- Prune any roots in this area using good arboricultural practices per the guidelines in this report or under the supervision of a Certified Arborist;
- Backfill with excavated material or better, immediately after completion of air spade excavation to prevent roots from drying out;
- Water trees periodically during construction;
- Apply a layer of 50mm depth mulch in a 2m radius around the trees;
- It is recommended that this measure be applied while a Certified Arborist is present.

8 TREE REMOVALS / INJURY / COMPENSATION

To facilitate the proposed works tree removals will be required. Refer to the charts below that detail the removals.

8.1 Compensation Notes

- All trees within site limits are within TRCA Regulated Areas and are subject to TRCA guidelines. Based on previous comments from the TRCA, compensation for trees greater than 10cm DBH is required (3:1 replacement ratio) detailed in Table 8.1;
- If Trees are within City ROW, City of Richmond Hill compensation is applied;
- No replacement trees are required for trees that are recommended for removal due to health (dead, disease, hazard);

8.2 Trca Compensation

Replacement trees are based on the following criteria:

- 3:1 replacement ratio for trees with TRCA Regulated Areas >10cm DBH;

All trees to be removed due to construction are within the TRCA Regulated Areas therefore a 3:1 ratio is required.

Table 8.1 – Removal and Compensation Table – TRCA

Bylaw	Removals – Construction	Exempt (<10cm DBH)	Subtotal	Ratio	Replacement Trees Required
TRCA / City	40	2	38	3:1	114
Totals	114				

- There are a total of **114 trees** that will be required as compensation by the City of Richmond Hill for the proposed removals.

8.3 Exemptions / Reductions from Compensation

The following trees have been excluded from the removal and compensation table as:

- Guidelines do not require compensation / replanting(s) for invasive species e.g. Russian Olive (*Elaeagnus angustifolia*)
- Tree sizes that do not meet the minimum By-law requirement e.g. trees <10cm DBH;

- Dead trees or Ash trees infested with EAB;
 - Shrubs e.g. Staghorn Sumac (*Rhus typhina*).
-

8.4 Overall Compensation Notes

Compensation for tree removals is given as a conservative value since many of the removed trees are within tree groupings and locations and sizes are not exact. These estimates will be finalized at the 90% design submission after a more detailed topographic survey is completed.

The total of replacement trees required is **114 trees**.

- TRCA compensation:
 - **114 trees** within City property limits / TRCA Regulated Areas;
- These replacement trees are recommended to be planted where possible within areas that were disturbed during construction. If adequate space is not available for replacement planting in these areas, then planting can occur within areas adjacent to disturbed limits where vegetation cover is sparse;
- If these areas still do not provide enough space for restoration planting than an alternate location will be agreed upon by Urban Forestry or cash in lieu could be considered.
- Replacement trees to be native species common to Richmond Hill / York Region.
- At this time, it is assumed compensation will be met through restoration planting within the study area or on adjacent lands.

9 CONCLUSION

Treed vegetation found within the study area ranges from young to mature and is a mixture of native and non-native species that are primarily naturally occurring. All trees fall within the TRCA Regulated Area limits.

Impacts to existing trees are anticipated to be moderate with the proposed design requiring 40 removals within City property owned by City of Richmond Hill and TRCA regulated areas. An additional 5 trees will have a TPZ encroachment. Root pruning by a Certified Arborist will mitigate injury to these trees. Given the implementation of the mitigation measures enclosed in this report, including protection of trees beyond the construction, significant impacts to trees to be preserved are not anticipated.

Care should be taken to protect trees to be retained with tree protection fencing as illustrated on the attached plans. Tree protection fencing shall be erected prior to the start of construction and demolition and maintained for the duration of the work. Priority should be given to protecting vegetation that will not be impacted by grading and construction as this vegetation along property lines provides a visual barrier, shade, noise and wind buffer between properties.

10 PRESERVATION AND PROTECTION RECOMMENDATIONS

The survival rates for trees, which are in proximity to construction, are dependent on the resultant changes to a variety of environmental and anthropogenic factors. These construction activities bring about changes to a variety of environmental features such as the existing microclimate that includes winds, air temperature, soil moisture, amount of available sunlight, soil quality, and the level of the water table. Increased human activities may also damage the structure and/or physiological activities of the trees. The full effects of any damage that occurs may not appear until several years after its occurrence. Thus, it is essential that both vegetative clearing and preservation methods follow the guidelines below and those generally accepted as keeping with good arboricultural and construction practices. The guidelines are subject to adjustments deemed reasonable and appropriate considering the proximity and number of trees involved and the site-specific servicing requirements.

10.1 General Recommendations

The following is a list of practical considerations for the construction phase of the project that applies to all trees that may be impacted by the construction:

- The tree protection fencing will be maintained until all construction is completed, soils are stabilized, and all the equipment has been removed from the site.
- Prior to the commencement of tree removals, all limits of the locations of the tree preservation fencing must be clearly staked in the field, installed per approved plans, and approved by the contract administrator. All trees within the tree preservation zone must be left standing. The tree removals must be coordinated in accordance and compliance with the Migratory Bird Convention Act (MBCA).
- All removals must be felled into the work area to ensure that damage does not occur to the trees within the tree preservation zone.
- Upon completion of the tree removals, all felled trees are to be removed from the site, and all should be brush chipped. All brush, roots and wood debris must be shredded into pieces that are smaller than 25 mm in size to ensure that any insect pests that could be present within the wood are destroyed.
- The Canadian Food and Inspection Agency (CFIA) has issued a prohibition of movement where the Emerald Ash Borer (EAB) has been confirmed. EAB has been found within the City of Richmond Hill and is within the EAB Regulated Area which covers most of Ontario and a portion of western Quebec. This directive pertains to the movement of regulated materials (including but not limited to ash wood or bark and ash wood chips or bark chips) from a regulated area. EAB regulated articles moving out of a regulated area must be accompanied by a Movement Certificate issued by the CFIA. Refer to the EAB Regulated Areas of Canada found on the CFIA website.
- Ash materials may be removed from the site and disposed of within the 'Regulated Area' (see CFIA website for the 'Regulated Area' limits). Should it be necessary to dispose of Ash products outside of the 'Regulated Area' a 'Movement Certificate' will be required from the CFIA prior to transport.
- Tree protection fencing must be constructed and installed as per the details on the approved Tree Preservation Plan. Upon installation of the fencing, the contractor will contact the contract

administrator to review and approve the fencing and its location prior to commencement of any grading work.

- Areas within the tree preservation zone (TPZ) are not to be used for any type of storage (e.g. storage of debris, construction material, surplus soils, and construction equipment). No trenching or tunnelling for underground services shall be located within the tree protection zone or dripline of trees designated for preservation within or adjacent to the construction zone.
 - No grade changes shall occur within tree preservation zone unless approved as part of this report. If any grade changes may occur, either as a cut or fill situation, the consulting arborist must be notified prior to such work occurring to ensure that all precautions to preserve the tree are made.
 - Trees shall not have any rigging cables or hardware of any sort attached or wrapped around them, nor shall any contaminants be dumped within the protective areas. Further, no contaminants shall be dumped or flushed where they may come into contact with the feeder roots of the trees.
 - If it is necessary to remove additional limbs or portions of trees after construction has commenced, in order to accommodate the construction, the consulting arborist is to be informed and under their direction the removal is to be executed carefully and in full accordance with arboricultural techniques, by a certified arborist.
-

10.2 Root Pruning Practices

- All approved root pruning is to take place by or under the supervision of an arborist and in accordance good arboricultural practices.
 - Pruned root ends shall be neatly and squarely trimmed and the area shall be backfilled with clean native fill as soon as possible to prevent desiccation and promote root growth.
 - The exposed roots shall not be allowed to dry out and an appropriate watering schedule shall be undertaken (e.g. water bi-weekly to field capacity between **June 1st and September 15th** so that the roots maintain optimum soil moisture during construction and backfilling operations.
 - Backfilling shall occur immediately and shall be with clean uncontaminated topsoil from an approved source. It is recommended that texture of backfill be coarser than existing soils, and that backfill comes into clean contact with existing soils, i.e. remove air pockets, sod, etc.
-

10.3 Branch Pruning Practices

- All limbs damaged or broken during construction shall be pruned cleanly, utilizing by-pass secateurs in accordance with approved arboricultural practices. Should there be a potential risk of transfer of disease from infected to non-infected trees, tools must be disinfected after pruning each tree by dipping in methyl hydrate. This practice is particularly important during periods of tree stress and when pruning many members of the same genera, within which a disease could be spread quickly (i.e., Verticillium Wilt on Maples or Fireblight on genera of the Rosaceae family).
- All pruning cuts should be made to a growing point such as a bud, twig or branch, cut just outside the branch collar (the swollen area at the base of the branch that sometimes has a bark ridge), and perpendicular to the branch being pruned rather than as close to the trunk as possible. This minimizes the site of the wound. No stubs should be left. Poor cut location, poor cut angle and torn cuts are not acceptable.

- Extensive pruning is best completed before plants break dormancy. Pruning should be limited to the removal of no more than 25% of the total bud and leaf bearing branches. Pruning should include the careful removal of:
 - Deadwood;
 - branches that are weak, damaged, diseased and those which will interfere with construction activity,
 - secondary leaders of conifers,
 - trunk and root suckers,
 - trunk waterspouts, and
 - tight V-shaped or weak crotches (included unions).
- Any branches that overhang the work area and require pruning are to be pruned using good arboricultural practices utilizing by-pass secateurs in accordance with American National Standard (ANSI) A300 (Part 1) – 2008 Pruning.
- The Contractor must report immediately any damage to trees such as broken limbs, damage to roots, or wounds to the main trunk or stem systems so that the damage can be assessed immediately.

10.4 Construction Implementation

Pre-Construction:

- A site meeting will be held with Contractor and Contract Administrator to review the clearing limits and confirm the installation location for the temporary tree protection fence;
- Tree removal along the tree retention limit must be carefully felled away from the tree retention limit and into the construction / development area. Stumps adjacent to trees identified for retention are to be flush cut and not chipped or grubbed to avoid impacts to retained trees.

Construction:

- Periodic inspections will be undertaken by the site supervisor to ensure that the mitigation measures are being maintained during construction;
- The temporary protection fence is to be maintained throughout the entire construction period. No equipment storage, flushing of fuel, washing of construction equipment, and storage of spoil or construction debris is to occur behind the temporary protection fence;
- To avoid root zone impacts on trees to be retained, excavated material will not be stored against the tree protection barrier;

Post-Construction:

- The temporary protection fence will be removed last after all the construction has ended, soils are stabilized, and all the equipment has been removed.

11 LITERATURE CITED

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12 LIMITATIONS OF ASSESSMENT

- It is our policy to attach the following clause regarding limitations. We do this to ensure that the client is aware of what is technically and professionally realistic in retaining trees.
- The assessment of the trees presented in this report has been made using accepted arboricultural techniques. These include a visual examination of all the above ground parts of the tree for structural defects, scars, external indications of decay such as fungal fruiting bodies, evidence of attack by insects, discoloured foliage, the condition of any visible root structures, the degree and direction of lean (if any), the general condition of the trees and the surrounding site, and the proximity of property and people. Except where specifically noted, the trees were not cored, probed or climbed and there was no detailed inspection of the root crowns involving excavations.
- Notwithstanding the recommendations and conclusions made in this report, it must be recognized that trees are living organisms, and their health and vigour constantly change over time. They are not immune to changes in site conditions or seasonal variations in the weather conditions.
- While reasonable efforts have been made to ensure that the subject trees are healthy, no guarantees are offered, or implied, that these trees or any of their parts will remain standing. It is both professionally and practically impossible to predict with absolute certainty the behaviour of any single tree or its component parts under all circumstances. Inevitably, a standing tree will always pose some level of risk. Most trees have the potential for failure under adverse weather conditions, and the risk can only be eliminated if the tree is removed.

APPENDIX

A

TREE PRESERVATION
TABLES

Table 1: Tree Inventory and Preservation Charts

Project: Connor Building				Field Work Completed By:				ST & ER			Date:	22-Feb-24	
<u>Tree Assessment Criteria:</u> TI - Trunk Integrity: assessment of the trunk for any defects or weaknesses. CS - Canopy Structure: assessment of scaffold branches, unions and canopy CV - Canopy vigour: assessment of the health of the tree, based on the % of deadwood, disease, pests & live crown								<u>Tree Condition</u> Good: tree displays less than 15% deficiency/defect within the given tree assessment criteria (TI,CS,CV) Fair: tree displays 15-40% deficiency/defect within the given tree assessment criteria (TI,CS,CV) Poor: tree displays greater than 40% deficiency/defect within the given tree assessment criteria (TI,CS,CV)					
<u>Conditions:</u> G=Good, F=Fair, P=Poor, D=Dead				<u>Legend:</u> <div><div></div>Trees to be Preserved / Retained</div> <div><div></div>Trees to be Removed</div> <div><div></div>Potential Transplant Candidate</div> <div><div></div>Dead / Hazard Trees to be removed</div>									
Tree #	Botanical Name	Common Name	No.	DBH (cm)	Tree Condition			Dripline Radius (m)	Tree Location	Tree Protection Zone (m)	Recommendation	Remarks	
					TI	CS	CV						
T1	<i>Acer platanoides</i>	Norway maple	1	30	G	G	F	4	City		Remove	Dieback	
G1	<i>Acer negundo</i>	Manitoba maple	6	17, 20, 9, 9, 10, 12	G	F	F	4	City	2.4	Remove	Tar spots, minor die back, broken leader on one 9cm DBH. Previously tagged 581-585. Buckthorn in understory	
580	<i>Tilia americana</i>	Basswood	1	55	G	G	F	6	City	3.6	Retain	Slight lean, minor dieback	
579	<i>Thuja occidentalis</i>	Eastern White Cedar	1	20	G	G	G	3	City	2.4	Retain		
578	<i>Acer campestre</i>	Hedge Maple	1	20, 10, 15, 20, 15	F	P	G	3	City	2.4	Retain	Multi-stem, broken leaders	
T2	<i>Fraxinus quadrangulata</i>	Blue Ash	1	11	G	G	G	2	City	2.4	Retain	No evidence of EAB	
576	<i>Pinus nigra</i>	Black Pine	1	40	G	G	P	5	City	2.4	Retain	Suppressed by T3. Buckthorn crowding understory	
577	<i>Acer campestre</i>	Hedge Maple	1	20, 15, 14	P	P	P	8	City	2.4	Retain	Large split and broken main leader, heavy dieback	
T3	<i>Fraxinus quadrangulata</i>	Blue Ash	1	50	P	G	P	7	City	3	Retain	Heavy die back, evidence of EAB	
T4	<i>Fraxinus quadrangulata</i>	Blue Ash	1	11	G	G	G	2	City	2.4	Retain	No evidence of EAB	
572	<i>Salix alba 'Tristis'</i>	White Willow	1	85	F	F	G	8	City	5.4	Retain	Part of canopy suppressed by 573, watersprouts, major leader pruned	
573	<i>Salix alba 'Tristis'</i>	White Willow	1	100	G	F	G	13	City		Remove	Major branch pruned	
T5	<i>Tilia americana</i>	Basswood	1	20	G	G	G	5	City	2.4	Retain	Beginning to be suppressed by 573	
T6	<i>Pinus nigra</i>	Black Pine	1	35	G	G	F	4	City	2.4	Retain		
T7	<i>Picea abies</i>	Norway Spruce	1	45	G	G	P	6	City		Remove	Heavy dieback	
T8	<i>Salix alba 'Tristis'</i>	White Willow	1	75	F	P	G	8	City	4.8	Remove	Major leader pruned, gypsy moths in trunk wound	
T9	<i>Salix alba 'Tristis'</i>	White Willow	1	100	P	P	F	7	City	6	Retain	Trunk splits, major leaders broken. Monitor.	
T10	<i>Salix alba 'Tristis'</i>	White Willow	1	100	F	F	G	9	City	6	Retain		
T11	<i>Salix alba 'Tristis'</i>	White Willow	1	120	F	F	G	10	City	6	Retain	Large leader pruned	
T12	<i>Ulmus pumila</i>	Siberian Elm	1	15	G	F	F	3	City	2.4	Retain	Chlorosis, insect holes in leaves	
T13	<i>Elaeagnus angustifolia</i>	Russian Olive	1	30, 10	F	P	P	6	Region	2.4	Retain	Suppressed by grapevine, virginia creeper. Several leaders dead	
G2	<i>Juglans nigra</i>	Black Walnut	2	20, 25	G	G	G	5	City	2.4	Retain	Trembling aspen saplings in understorey	
T14	<i>Populus tremuloides</i>	Trembling Aspen	1	10	G	G	G	2	City	1.8	Retain	Many trembling aspen saplings surrounding	

Table 1: Tree Inventory and Preservation Charts

Project: Connor Building				Field Work Completed By:				ST & ER			Date:	22-Feb-24	
Tree Assessment Criteria:								Tree Condition					
TI - Trunk Integrity: assessment of the trunk for any defects or weaknesses.								Good: tree displays less than 15% deficiency/defect within the given tree assessment criteria (TI,CS,CV)					
CS - Canopy Structure: assessment of scaffold branches, unions and canopy								Fair: tree displays 15-40% deficiency/defect within the given tree assessment criteria (TI,CS,CV)					
CV - Canopy vigour: assessment of the health of the tree, based on the % of deadwood, disease, pests & live crown								Poor: tree displays greater than 40% deficiency/defect within the given tree assessment criteria (TI,CS,CV)					
Conditions:				Legend:									
G=Good, F=Fair, P=Poor, D=Dead				<div></div> Trees to be Preserved / Retained				<div></div> Potential Transplant Candidate					
				<div></div> Trees to be Removed				<div></div> Dead / Hazard Trees to be removed					
Tree #	Botanical Name	Common Name	No.	DBH (cm)	Tree Condition			Dripline Radius (m)	Tree Location	Tree Protection Zone (m)	Recommendation	Remarks	
					TI	CS	CV						
G3	<i>Juglans nigra, Populus tremuloides</i>	Black Walnut, Trembling Aspen	14	10-20	G	G	G	1-3	City	2.4	Retain	2 Black Walnut, 12 Trembling Aspen	
G4	<i>Juglans nigra, Acer negundo</i>	Black Walnut, Manitoba Maple	4	15-25	G	G	G-P	4	City	2.4	Retain	3 Manitoba Maple (heavy dieback), 1 Black Walnut good condition	
T15	<i>Malus, Sp.</i>	Crab Apple	1	45, 15	F	F	P	6	City	3	Remove	Heavy dieback, large split in a main branch	
G5	<i>Thuja occidentalis, Syringa vulgaris</i>	Eastern White Cedar, Lilac	5	5-20	F	F	P	3	City		Remove	Heavy lean and dieback on cedars (2), lilacs multi-stem. Previously tagged 574 part of grouping	
586			1						City		Remove	Dead	
589	<i>Pinus sylvestris</i>	Scots pine	1	30	G	G	P	4	City	2.4	Remove	Heavy dieback, suppressed by 597	
588	<i>Pinus sylvestris</i>	Scots pine	1	20	G	G	P	4	City	2.4	Retain	Heavy dieback	
T16	<i>Malus, Sp.</i>	Crabapple	1	5-15	P	P	P	5	City	2.4	Retain	Crowded by buckthorn, heavy dieback	
592	<i>Pinus nigra</i>	Black Pine	1	40	G	G	F	6	City	2.4	Retain	Base crowded by buckthorn and Manitoba Maple	
591	<i>Pinus nigra</i>	Black Pine	1	35	G	G	F	7	City	2.4	Retain	Base crowded by buckthorn and Manitoba Maple	
590	<i>Pinus nigra</i>	Black Pine	1	30	G	G	F	7	City	2.4	Retain		
594	<i>Juglans nigra</i>	Black Walnut	1	10	G	G	G	4	City	1.8	Retain	Suppressed by pines	
595	<i>Pinus nigra</i>	Black Pine	1	40	G	G	F	3	City	2.4	Remove	Grading within dripline, monitor during construction	
596	<i>Picea abies</i>	Norway Spruce	1	50	G	G	G	5	City	3	Remove	Buckthorn at base	
598	<i>Acer negundo</i>	Manitoba maple	1	20, 25	G	P	F	7	City	2.4	Remove	Multi-stem, heavy lean	
599	<i>Thuja occidentalis</i>	Eastern White Cedar	1	15	G	G	P	2	City	2.4	Remove	Suppressed	
90	<i>Pinus nigra</i>	Black Pine	1	40	G	G	F	5	City	2.4	Remove	Dieback	
499	<i>Prunus sylvestris</i>	Sweet cherry	1	15, 16	G	P	P	3	Private	2.4	Retain	Suppressed, multi-stem	
500	<i>Pinus nigra</i>	Black Pine	1	35	G	G	P	4	City	2.4	Remove	Dieback	
498	<i>Crataegus, Sp.</i>	Hawthorn	1	5-12	G	F	G	5	City	2.4	Remove	Multi-stem	
496	<i>Pinus sylvestris</i>	Scots Pine	1	22	G	G	P	3	City	2.4	Remove	Buckthorn crowding base	
G6	<i>Thuja occidentalis</i>	Eastern White Cedar	4	14-17	G	G	G	1	City	2.4	Remove	Previously tagged 492-495	

Table 1: Tree Inventory and Preservation Charts

Project: Connor Building				Field Work Completed By:				ST & ER			Date:	22-Feb-24
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Conditions:				Legend:								
G=Good, F=Fair, P=Poor, D=Dead				Trees to be Preserved / Retained				Potential Transplant Candidate				
				Trees to be Removed				Dead / Hazard Trees to be removed				
Tree #	Botanical Name	Common Name	No.	DBH (cm)	Tree Condition			Dripline Radius (m)	Tree Location	Tree Protection Zone (m)	Recommendation	Remarks
					TI	CS	CV					
T17	<i>Pinus sylvestris</i>	Scots pine	1	25	G	G	P	3	Private	2.4	Retain	Suppressed by buckthorn
491	<i>Acer negundo</i>	Manitoba maple	1	16	P	P	P	5	Private	2.4	Retain & Monitor until Removal Consent Obtained	Lean, trunk split, mushrooms at base, heavy die back
489	<i>Pinus sylvestris</i>	Scots Pine	1	15	G	G	P	3	City	2.4	Remove	Suppressed, dieback
G7	<i>Acer negundo</i>	Manitoba maple	2	10-30	G	F	F	7	City	2.4	Remove	Multi-stem
T18	<i>Pinus nigra</i>	Black Pine	1	27	G	G	F	5	City	2.4	Remove	
T19	<i>Pinus nigra</i>	Black Pine	1	35	G	F	P	6	City		Remove	Suppressed, dieback
T20	<i>Pinus nigra</i>	Black Pine	1	40	G	G	P	5	City	2.4	Remove	Suppressed, dieback
T21	<i>Thuja occidentalis</i>	Eastern White Cedar	1	15	G	G	P	1	City	2.4	Remove	Suppressed, dieback
488	<i>Acer platanoides</i>	Norway maple	1	60	G	G	G	9	City		Remove	
487	<i>Acer platanoides</i>	Norway maple	1	45	G	G	F	7	City	3	Remove	
486			1						City		Remove	Dead
485			1						City		Remove	Dead
484			1						City		Remove	Dead
483	<i>Juglans nigra</i>	Black Walnut	1	15	G	G	P	2	City	2.4	Remove	
482	<i>Juglans nigra</i>	Black Walnut	1	20	G	G	G	5	City	2.4	Remove	Suppressed by 484, dieback
T22	<i>Acer platanoides</i>	Norway maple	1	50	G	G	G	6	Private	3	Retain	Roots exposed on slope
T23			1						Private		Retain & Monitor until Removal Consent Obtained	Dead

APPENDIX

B

PHOTOS





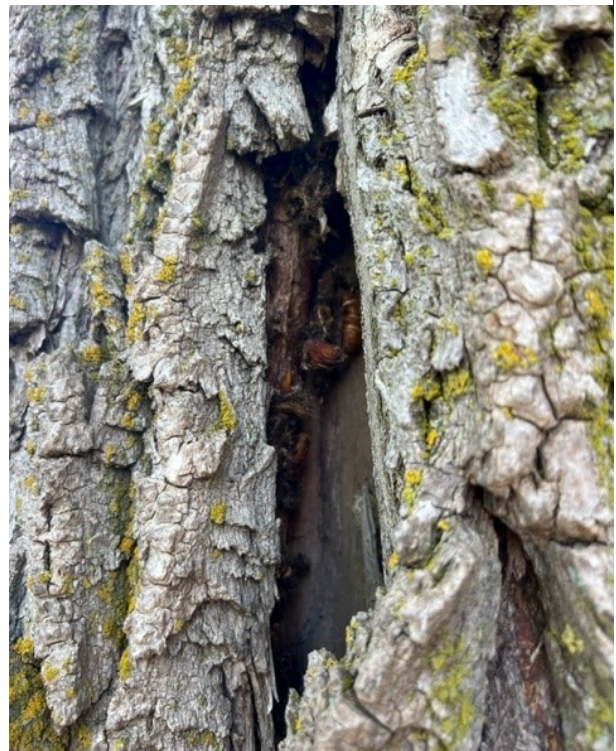
1. G1 grouping- Buckthorn in understory, to be removed.



2. T7- Norway spruce with heavy dieback. To be removed.



3. T8- Willow to be removed.



4. T8- Gypsy moth wound in trunk.



5. T12- Siberian elm to be retained.



6. T15- Crab apple to be removed.



7. T1- Norway Maple to be removed.



8. 588- Scots pine to be retained.
589- Scots pine to be removed.



9. 587- In existing patio to be removed.



10. 487- Norway maple to be removed.



11. T22- Norway maple with exposed roots on slope. To be retained.



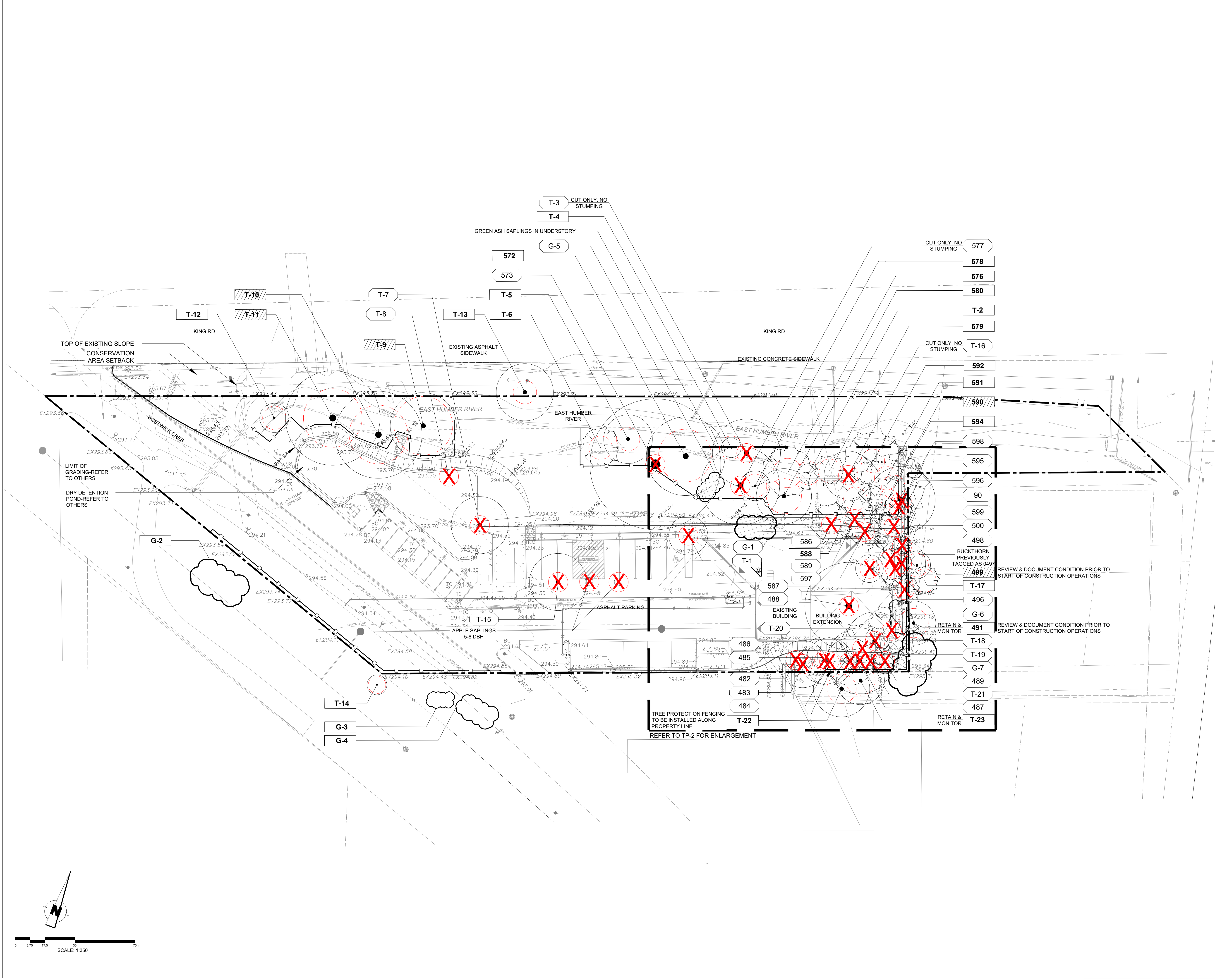
12. 488- Norway maple to be removed.

APPENDIX



C

TREE MANAGEMENT PLAN



KEY MAP

LEGEND

- EXISTING SURVEYED CONIFEROUS TREES
- EXISTING SURVEYED DECIDUOUS TREES
- TREE PROTECTION ZONE PER RICHMOND HILL BY-LAWS
- EXISTING TREE GROUPING
- EXISTING TREE GROUP/ WOODLOT TO BE REMOVED
- EXISTING TREE TO BE REMOVED
- LIMIT OF WORK
- LIMIT OF GRADING
- IDENTIFICATION NUMBER FOR EXISTING INDIVIDUAL TREE OR GROUP TO BE REMOVED
- IDENTIFICATION NUMBER FOR EXISTING INDIVIDUAL TREE OR GROUPING TO REMAIN REFER TO TREE INVENTORY CHART
- IDENTIFICATION NUMBER FOR EXISTING INDIVIDUAL TREE OR GROUPING TO BE INJURED. REFER TO TREE INVENTORY APPD
- TREE PROTECTION FENCING REFER TO DETAIL 1/L500

DRAWING INFORMATION

ORIGINAL DESIGN AND/OR DRAWING BASE COMPLETED BY:
ARCHITECTURE 49
YEAR: 2024
ADDRESS: 20 QUEEN ST W, SUITE 2300 TORONTO, ON M5H 3R3

NO	DATE	REVISION/ISSUED	BY	APPD
5	2025/03/20	ISSUED FOR TENDER	ER	ST
4	2025/03/17	SPA 3rd SUBMISSION	ER	ST
3	2025/01/16	ISSUED FOR PERMIT APPLICATION	ER	ST
2	2024/12/16	RE-ISSUED FOR SPA	ER	ST
1	2024/05/08	ISSUED FOR SPA	ER	ST
NO	DATE	REVISION/ISSUED	BY	APPD

Landscape Architecture
582 Lancaster Street West
Kitchener, ON N2K 1M3
T 519-743-8777
www.wsp.com

CLIENT:

CITY OF RICHMOND HILL
225 E BEAVER CREEK RD

PROJECT TITLE:

CONNOR BUILDING
RENOVATIONS

SITE ADDRESS:

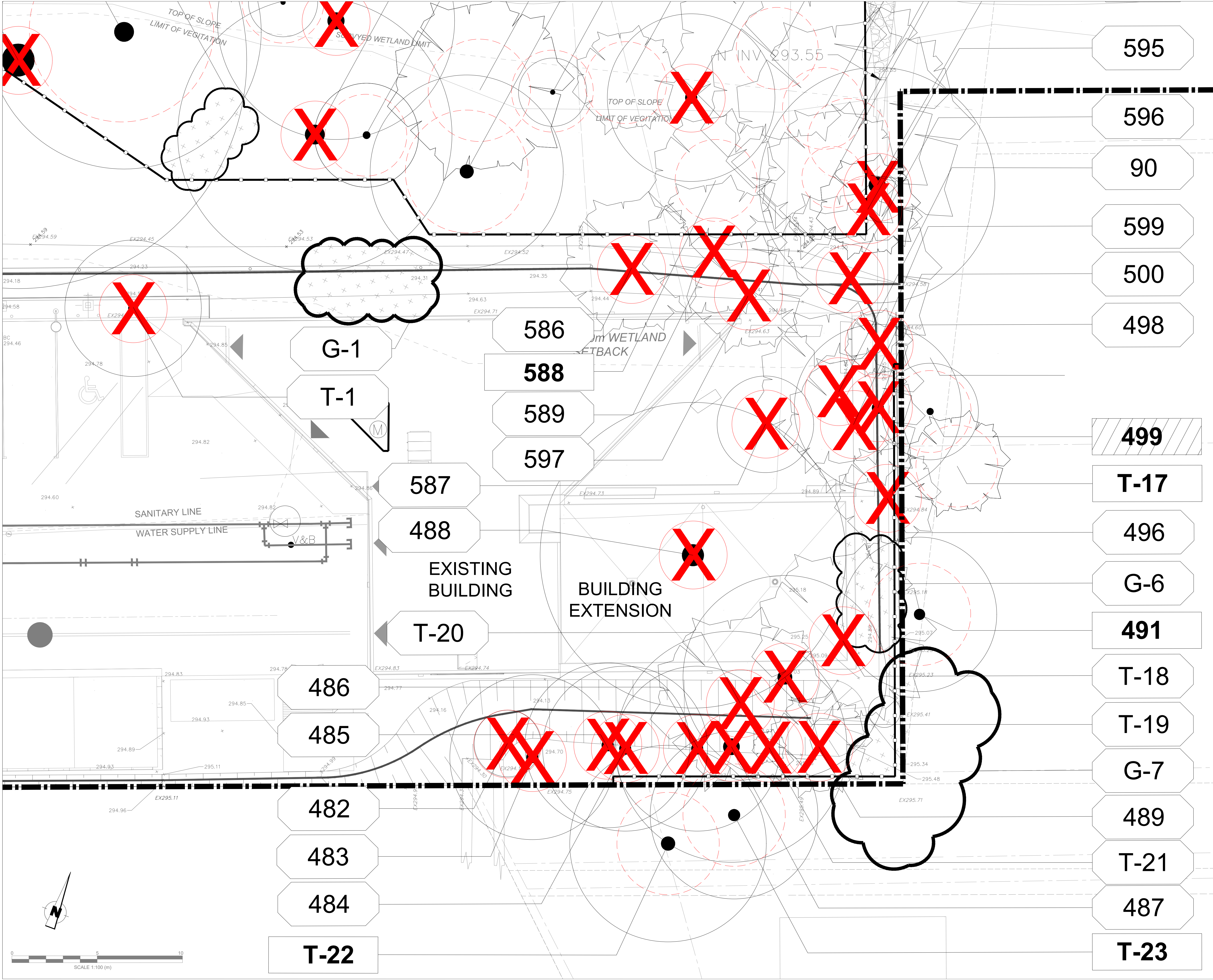
39 KING RD
RICHMOND HILL, ON L4E 2W1

DRAWING TITLE:

TREE MANAGEMENT PLAN

STAMP

DESIGNED	ER	DRAWN	ER	CHECKED	ST
SCALE	1:300	DATE	MARCH 2025	DWG. NUMBER	TP-1
PROJECT NUMBER	CA0010351.5022				



KEY MAP

LEGEND

- EXISTING SURVEYED CONIFEROUS TREES
- EXISTING SURVEYED DECIDUOUS TREES
- TREE PROTECTION ZONE PER RICHMOND HILL BY-LAWS
- EXISTING TREE GROUPING
- EXISTING TREE GROUP/ WOODLOT TO BE REMOVED
- EXISTING TREE TO BE REMOVED
- LIMIT OF WORK
- LIMIT OF GRADING
- IDENTIFICATION NUMBER FOR EXISTING INDIVIDUAL TREE OR GROUP TO BE REMOVED
- IDENTIFICATION NUMBER FOR EXISTING INDIVIDUAL TREE OR GROUPING TO REMAIN REFER TO TABLE 1 (L1 TO L11) FOR TREE INVENTORY CHART
- IDENTIFICATION NUMBER FOR EXISTING INDIVIDUAL TREE OR GROUPING TO BE INJURED. REFER TO TABLE 1 (L1 TO L11) FOR TREE INVENTORY CHART
- TREE PROTECTION FENCING REFER TO DETAIL 1/L500

DRAWING INFORMATION

ORIGINAL DESIGN AND/OR DRAWING BASE COMPLETED BY:
ARCHITECTURE 49
YEAR: 2024
ADDRESS: 20 QUEEN ST W, SUITE 2300 TORONTO, ON M5H 3R3

NO	DATE	REVISION/ISSUED	BY	APPD
5	2025/03/20	ISSUED FOR TENDER	ER	ST
4	2025/03/17	SPA 3rd SUBMISSION	ER	ST
3	2025/01/16	ISSUED FOR PERMIT APPLICATION	ER	ST
2	2024/12/16	RE-ISSUED FOR SPA	ER	ST
1	2024/05/08	ISSUED FOR SPA	ER	ST

wsp Landscape Architecture
582 Lancaster Street West
Kitchener, ON N2K 1M3
T 519-743-8777
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CLIENT:
CITY OF RICHMOND HILL
225 E BEAVER CREEK RD

PROJECT TITLE:
CONNOR BUILDING RENOVATIONS

SITE ADDRESS:
39 KING RD
RICHMOND HILL, ON L4E 2W1

DRAWING TITLE:
TREE MANAGEMENT PLAN

STAMP

DESIGNED	ER	DRAWN	ER	CHECKED	ST
SCALE 1:100			DATE MARCH 2025		
PROJECT NUMBER CA0010351.5022			DWG. NUMBER TP-2		

Tree Preservation Notes and Guidelines

Establishment of Tree Protection Zone (TPZ):

- Tree preservation measures, including the establishment of tree protection zone (TPZ) shall apply to the vegetation identified to be retained and protected. The tree protection zone shall consist of tree protection fencing as per City of Richmond Hill Standard, placed at the dripline of vegetation to be preserved. Refer to details on this sheet.
- No grade changes shall occur within tree protection zone. In the event that grade changes occur either as a cut or fill situation, the consulting arborist must be notified so that precautions to preserve the tree can be determined prior to the placement of fill or excavation activities.
- Every precaution must be taken to prevent damage to trees and root systems from damage, compaction and contamination resulting from the construction to the satisfaction of the consulting arborist.
- Trees that require pruning to permit construction activities will be done so in accordance with good arboricultural practices. In the event that it is necessary to remove additional limbs or portions of trees, after construction has commenced, to accommodate construction, the consulting arborist is to be informed and under their direction the removal is to be executed carefully and in full accordance with arboricultural techniques, by a certified arborist.
- Any damage to trees such as broken limbs, damage to roots, or wounds to the main trunk or stem systems are to be reported to the consulting arborist so that the damage can be assessed immediately and mitigation can be promptly implemented.

Tree Protection Zone:

Applies to trees located the limit of grading or noted otherwise. These trees are to be preserved and will have silt / tree protection fencing installed at along the limit of grading / limit of work to establish the tree protection zone. Any damage to trees such as broken limbs, damage to roots, or wounds to the main trunk or stem systems are to be reported to the consulting arborist so that the damage can be assessed immediately and mitigation can be promptly implemented. Within a tree protection zone there is to be:

- No construction
- No altering of grade by adding fill, excavating, trenching, scraping, dumping or disturbance of any kind.
- No storage of construction materials, equipment, soil, construction waste or debris within the drip line.
- No movement of vehicles, equipment
- No parking of vehicles or machinery
- No digging, boring
- No rigging cables shall be wrapped around or installed in trees
- No contaminants will be placed over root system
- No contaminants will be dumped or flushed where feeder roots of trees exist

Work within a Tree Protection Zone:

If work must be conducted within a tree protection zone the contractor should minimize soil compaction and mechanical root damage by utilizing one of the following four methods:

1. Applying 150-300mm of mulch to area. Upon completion remove excess mulch leaving a 100mm depth layer of mulch.
2. Laying 20mm thick plywood or 100x100mm wood beams over a 100+mm thick layer of wood chip mulch. Upon completion remove plywood and leave mulch layer in place.
3. Applying 100-150mm depth of gravel over a tauT, staked geotextile fabric. Upon completion remove gravel and geotextile.
4. Placing commercial logging or road mats on top of a mulch layer. Upon completion remove mats, stone, geotextile, and mulch exceeding 100mm thick will be removed from the tree preservation area once the threat of soil or root damage has passed.

Tree Preservation and Protection Recommendations:

The survival rates for trees, which are in proximity to construction sites are dependent on the resultant changes to a variety of environmental and anthropogenic factors. These construction activities bring about changes to a variety of environmental features including the existing microclimate including winds, temperature, soil moisture, amount of available sunlight, soil quality, and the level of the water table. Increased human activities may also damage the structure and / or physiological activities of the trees. The full effects of the damage may not appear until several years after its occurrence. Thus, it is essential that both vegetative clearing and preservation methods follow the guidelines below and those generally accepted as keeping with good horticultural and construction practices. The guidelines are subject to adjustments deemed reasonable and appropriate considering the proximity and number of trees involved and the site-specific servicing requirement.

General Recommendations:

- All trees within the tree preservation zone must be left standing. The tree removals must be coordinated to be completed outside of the bird nesting season, **April 1 to August 31**.
- All removals must be felled into the work area to ensure that damage does not occur to the trees within the tree preservation zone.
- Upon completing of the tree removals, all felled trees are to be chipped. This work must be completed outside of the bird nesting season, **April 1 to August 31**.
- Tree protection fencing / silt fence must be installed as per the City of Guelph Standard Silt Fence Detail and as shown on the approved Municipal Engineering Plan. Upon installation of the fencing, the contractor will contract the consulting arborist to review and approve the fencing and its location prior to commencement of any grading work.
- Areas within the tree preservation zone are not to be used for any type of storage (e.g. storage of debris, construction material, surplus soils, and construction equipment). No trenching or tunnelling for underground services shall be located within the tree protection zone or dripline of trees designated for preservation within or adjacent to the construction zone.

Root Pruning:

- At the commencement of construction prune roots cleanly using acceptable arboricultural practices and immediately backfill with appropriate material. Roots over 2.5cm diameter that are to be cut should be pruned rather than left torn or crushed. The following are general methods of root pruning:
 1. Soil excavation using supersonic air tools, pressurized water or hand tools, followed by selective root cutting.
 2. Cutting through the soil along a predetermined line on the surface using tool specifically designed to cut roots
 3. Mechanically excavating (e.g. backhoe) the soil and pruning what is left of the exposed roots.
 4. Cuts to be made with hand pruning shears, by-pass blade, pruning saw. Do not use anvil type pruners.
- No tree roots shall be pruned without written approval by the City of Richmond Hill. Pruning must be identified on the City approved tree preservation plan.
- Approved pruning must be undertaken by an ISA certified arborist. No trades personnel are permitted to prune tree roots.

Pruning Practices:

- All limbs damaged or broken during the course of construction should be pruned cleanly, utilizing by-pass secateurs in accordance with approved horticultural practices undertaken by an ISA certified arborist. No tree branches shall be pruned without written approval by the City of Richmond Hill. Pruning must be identified on the City approved tree preservation plan.
- Should there be a potential risk of transfer of disease from infected to non-infected trees, tools must be disinfected after pruning each tree by dipping in methyl hydrate. This practice is particularly important during periods of tree stress and when pruning many members of the same genera, within which a disease could be spread quickly (i.e., Verticillium wilt on maples or fire blight on genera of the Rosaceae family).
- During excavation operations in which the root area is affected, the contractor is to prune all exposed roots cleanly. Pruned root ends are to be neatly and squarely trimmed and the area is to be backfilled with clean native fill as soon as possible to prevent desiccation and promote root growth. The exposed roots should not be allowed to dry out, and the contractor shall discuss watering of the roots with the consulting arborist so that the roots shall maintain optimum soil moisture during construction and backfilling operations, yet so not to interfere with construction operations. Backfilling must be with clean uncontaminated topsoil from an approved source. Texture must be coarser than existing soils, and to come into clean contact with existing soils (remove air pockets, sod, etc.)
- All pruning cuts should be made to a growing point such as a bud, twig or branch, cut just outside the branch collar (the swollen area at the base of the branch that sometimes has a bark ridge), and perpendicular to the branch being pruned rather than as close to the trunk as possible. This minimizes the site of the wound. No stubs should be left. Poor cut location, poor cut angle and torn cuts are not acceptable.
- Tree roots should not be excavated within the critical structural rooting area. This is the minimum area of the root system necessary to maintain vitality or stability of the tree. Typically this area extends to the dripline of the tree. The severing of one root can cause approximately 5-20% loss of the root system. A reduction of this area by greater than 30% can pose stability concerns for the tree.
- A slow release fertilizer eg. bone meal or approved equal to be applied to trees where root pruning or root damage has occurred. Apply per manufacturer's recommendations

- Extensive pruning is best completed before plants break dormancy. Pruning should be limited to the removal of no more than one third (1/3) of the total bud and leaf bearing branches. Pruning should include the careful removal of:
 - Deadwood,
 - Branches that are weak, damaged, diseased and those which will interfere with construction activity,
 - Secondary leaders of conifers,
 - Trunk and root suckers,
 - Trunk waterpouts, and
 - Tight V-shaped or weak crotches (included unions).

The contractor must immediately report any damage to trees such as broken limbs, damage to roots, or wounds to the main trunk or stem systems so that the damage can be assessed immediately.

The tree protection fencing will be maintained until all construction is completed, soils are stabilized and all of the equipment has been removed from the site.

Tree Injury:

Typically tree roots extend 1.5 to 3 times beyond the dripline of the tree and are within the top 150mm of the soil. Types of damage from construction include:

- Physical injury
- Soil compaction
- Severing of roots
- Smothering of roots
- Split or broken branches
- Excessive pruning

Soil compaction reduces pore space, oxygen available to roots increases carbon dioxide accumulation, restricts root growth and the ability to absorb water and nutrients, as well as impairs drainage. Smothering of roots: 90% of fine absorbing roots are within the upper 150-300mm of the soil. Smothering with the addition of soil can kill the roots and stress the tree. Physical injury, split or broken branches hinder the trees ability to compartmentalize (close) wounds properly.

Key Map

Drawing Information

Original Design and/or Drawing Base Completed By:
Architecture 49
Year: 2024
Address: 20 Queen St W, Suite 2300 Toronto, ON M5H 3R3

5	2025/03/20	ISSUED FOR TENDER	ER	ST	
4	2025/03/17	SPA 3rd SUBMISSION	ER	ST	
3	2025/01/16	ISSUED FOR PERMIT APPLICATION	ER	ST	
2	2024/12/16	RE-ISSUED FOR SPA	ER	ST	
1	2024/05/08	ISSUED FOR SPA	ER	ST	
NO	DATE	REVISION/ISSUED	BY	APPD	

WSP

Landscape Architecture

582 Lancaster Street West

Kitchener, ON N2K 1M3

t. 519-743-8777

www.wsp.com

CLIENT:

CITY OF RICHMOND HILL
225 E BEAVER CREEK RD

PROJECT TITLE:

CONNOR BUILDING
RENOVATIONS

SITE ADDRESS:

39 KING RD
RICHMOND HILL, ON L4E 2W1

DRAWING TITLE:

TREE PROTECTION
NOTES & DETAILS

STAMP

STAMP

NO NOT FOR CONSTRUCTION

DESIGNED

ER

DRAWN

ER

CHECKED

ST

SCALE

DATE

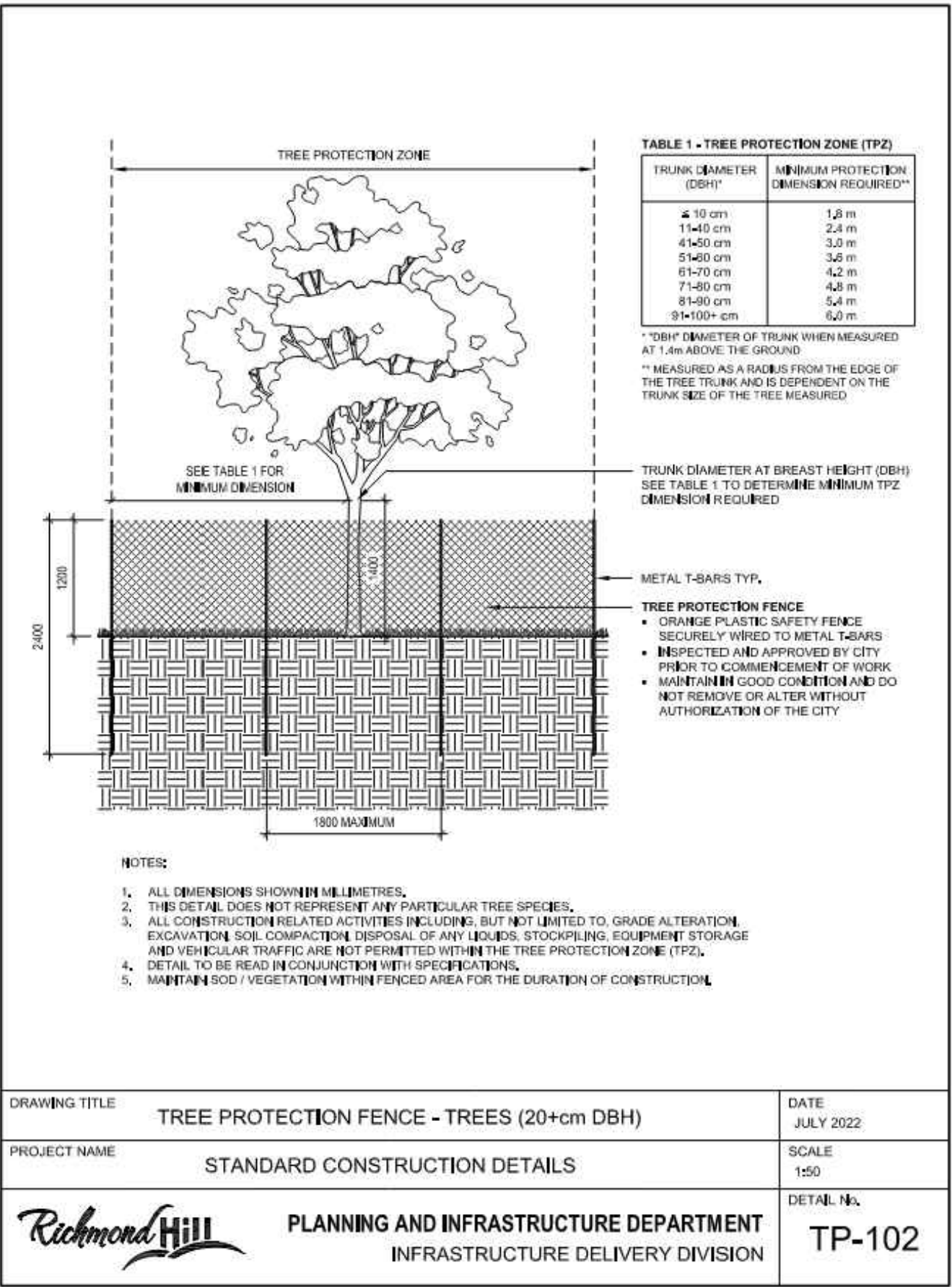
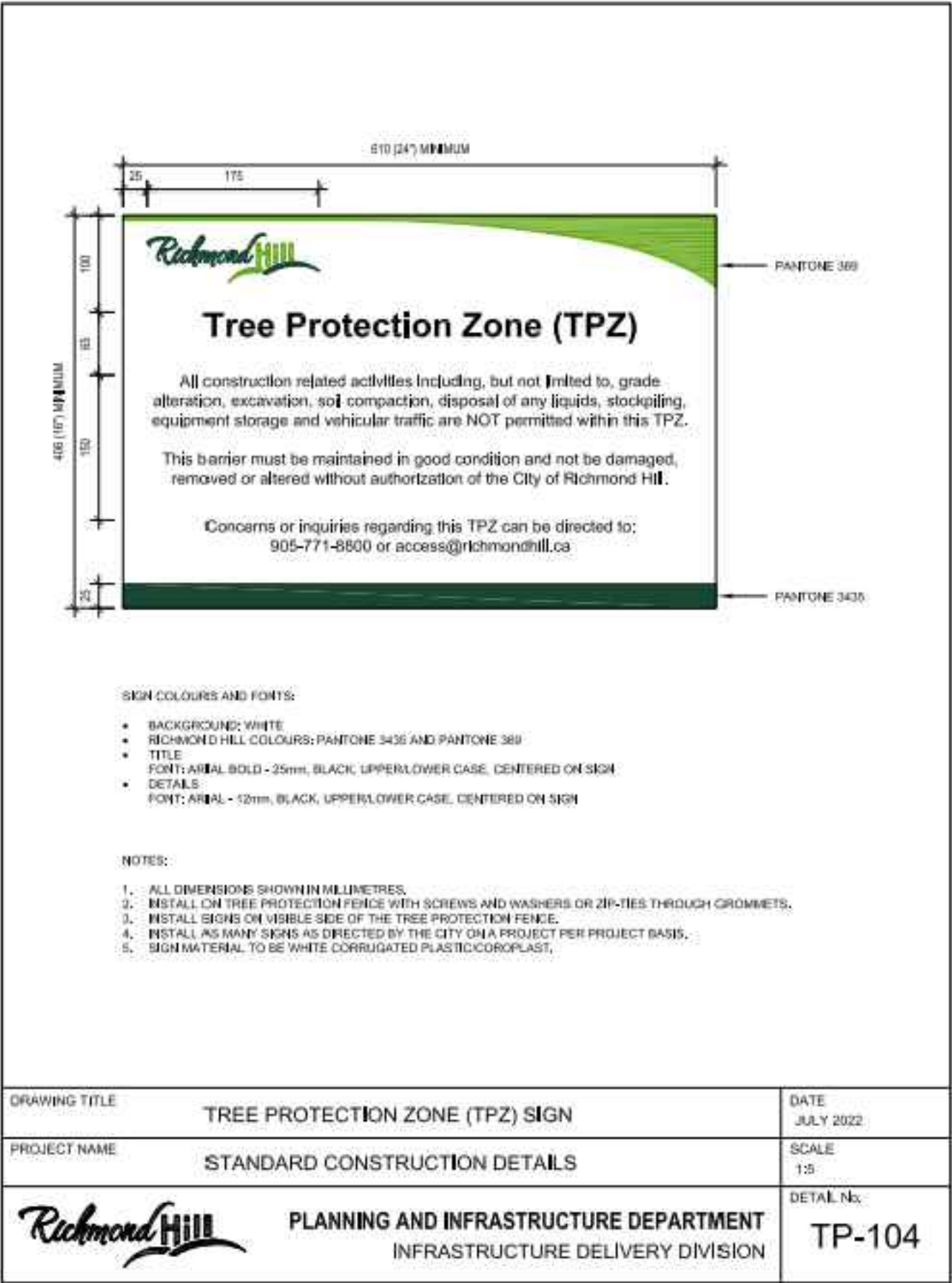
MARCH 2025

PROJECT NUMBER

DWG. NUMBER

CA0010351.5022

TP-3



APPENDIX

F1 DESIGNATED SUBSTANCES

Summary of Asbestos
Containing Materials, Haag
Canada, Dec. 13, 2021

SUMMARY OF ASBESTOS-CONTAINING MATERIALS AT THE CONNER BUILDNG (82)

Location: 39 King Road, Richmond Hill, Ontario
Our File: 2121000009-82

Prepared for:

Mr. Alexander Mandatori, P.Eng., MBA, PMP
Manager, Capital Planning & Delivery
Facility Management Division
City of Richmond Hill
225 East Beaver Creek Road
Richmond Hill, Ontario
L4B 3P4

Prepared by:



Kelly (Smith) Newell, B.Sc.

December 13, 2021

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APPENDIX B: ACTION/REVISION LOG

**APPENDIX C: RESULTS OF HISTORICAL ANALYSES OF BULK SAMPLES FOR ASBESTOS
CONTENT**

APPENDIX D: REGULATORY DISCUSSION

1.0 SUMMARY

Haag Canada Inc. (Haag) was retained by the City of Richmond Hill to conduct a review of existing information related to the presence of asbestos-containing materials in the Conner Building (82) located at 39 King Road in Richmond Hill, Ontario.

The following is our summary report.¹

Based on our review, **asbestos containing materials** are present in the following accessible applications at the site:

- **Thermal insulation (assumed asbestos) applied to piping in Room 105 (Truck Bay);**
- **Drywall joint compound applied to walls and/or ceiling throughout the building; and,**
- **Vinyl floor tiles (12" x 12") in Room103C (Mechanical Room).**

¹ This engineering report has been written for the City of Richmond Hill's sole use and purpose, and only the City of Richmond Hill has the authority to distribute this report to any other person, firm, or corporation. Haag Canada Inc. and its agents and employees do not have and do disclaim any contractual relationship with, or duty or obligation to, any party other than the addressee of this report and the principals for whom the addressee is acting. Only the engineers who signed this document have the authority to change its contents and then only in writing to you. This report addresses the results of work completed to date. Should additional information become available, we reserve the right to amend, as warranted, any of our conclusions.

2.0 INTRODUCTION

Haag Canada Inc. (Haag) was retained by the City of Richmond Hill (City) to conduct a review of existing information related to the presence of asbestos-containing materials in the Conner Building (82) located at 39 King Road in Richmond Hill, Ontario².

This summary report was completed to identify readily observable asbestos-containing materials present at the site and to provide guidance so that all materials of concern are handled in accordance with applicable regulatory requirements and industry standards and guidelines.

The building was reportedly constructed in 1974. Floor plans provided by the City are included in Appendix A.

2.1 Scope of Work

Our scope of work included:

- Review of relevant existing available information and historical data;
- Consolidation of historical reports; and
- Preparation of a summary report identifying the presence of asbestos-containing materials used in building construction materials.

3.0 DOCUMENTATION REVIEW

Haag completed a review of existing documentation prepared for City of Richmond Hill related to the locations of asbestos-containing materials present at the site. Information and bulk sample analysis results obtained from these reports were utilized by Haag in the preparation of our report.

In accordance with regulatory requirements, the asbestos survey reports are to be updated at least once every 12 months, and whenever any changes relating to the locations of ACM occur. An Action/Revision Log is included in Appendix B and is to be updated in accordance with the City's Asbestos Management Plan.

4.0 METHODOLOGY

4.1 Survey Methodology

Determination of the locations of asbestos-containing material is made based on the review of existing information, results of bulk sample analysis, visual observations, and physical characteristics of the applications, as well as our knowledge of the uses of asbestos in building materials.

² This engineering report has been written for the City of Richmond Hill's sole use and purpose, and only the City of Richmond Hill has the authority to distribute this report to any other person, firm, or corporation. Haag Canada Inc. and its agents and employees do not have and do disclaim any contractual relationship with, or duty or obligation to, any party other than the addressee of this report and the principals for whom the addressee is acting. Only the engineers who signed this document have the authority to change its contents and then only in writing to you. This report addresses the results of work completed to date. Should additional information become available, we reserve the right to amend, as warranted, any of our conclusions.

Sampling of materials is typically completed in a manner to prevent significant damage to building materials. Sampling that requires significant damage to building materials includes, but is not limited to, roofing materials, fire doors, caulking, mortar, mastics or cementitious levelling compound under vinyl flooring, acoustic ceiling tile adhesive, gaskets in piping, cementitious mortar associated with ceramic tile applications, internal components of boilers, paints and coatings, block filler paint, components of electrical equipment (i.e., electric wiring insulation, non-metallic sheathed cable, electrical panel partitions, arc chutes, high-grade electrical paper, etc.), concrete, asphaltic pavement, etc., and/or in locations that are presently inaccessible (i.e., in pipe chases, behind walls and above suspended gypsum board or plaster ceilings). Asbestos may also be present in the form of vermiculite insulation in cavities in concrete or cement block walls (used as in-fill insulation).

Samples of such materials should be collected as part of comprehensive project-specific designated substances surveys completed prior to renovations and/or demolition.

Asbestos-containing material" is defined as material that contains 0.5% or more asbestos by dry weight.

Bulk sampling of building materials was carried out in accordance with the minimum sampling requirements specified in Table 1 of O.Reg. 278/05. We recommend that additional samples of certain types of material which may have been mixed on site at the time of construction (plaster, drywall joint compound, ceiling texture coat, etc.) be tested for asbestos content prior to the disturbance of these materials at the time of renovations, alterations, or demolition work.

The asbestos analysis is completed using a stop positive approach. Only one result meeting regulated criteria is required to determine that a material is asbestos-containing, but all samples must be analyzed to conclusively determine that a material is non-asbestos. The laboratory stops analyzing samples from a homogeneous material once a result equal to or greater than the regulated criteria is detected in any of the samples of that material. All samples of a homogeneous material are analyzed if no asbestos is detected. In some cases, all samples are analyzed in the sample set regardless of result.

4.2 Assessment Methodology

Where required, the condition of all asbestos-containing materials is assessed during the survey. Assessment involves the evaluation of a number of factors, including:

- asbestos content;
- physical damage;
- water damage;
- accessibility;
- adjacent activity, vibrations;
- air distribution system (air plenum); and,
- friability.

Recommendations for appropriate corrective measures are based on findings of the assessment and consist primarily of either repair or removal (and replacement) of the asbestos-containing materials. Recommended corrective actions, if required, will be submitted under separate cover.

5.0 RESULTS AND DISCUSSION

On the basis of the survey work carried out, we report that **asbestos containing materials** are present in the following accessible applications:

- **Thermal insulation (assumed asbestos) applied to piping in Room 105 (Truck Bay);**
- **Drywall joint compound applied to walls and/or ceiling throughout the building; and,**
- **Vinyl floor tiles (12" x 12") in Room 103C (Mechanical Room).**

Glass fibre insulation is readily visually distinguishable (typically yellow in colour) from asbestos-containing insulation materials and was, therefore, not tested for asbestos content.

All thermal insulation, with the exception of glass fibre material, should be assumed to contain asbestos unless a bulk sample analysis indicates otherwise.

A summary of the locations and conditions of asbestos-containing materials identified is presented in Table 5.1. The locations of accessible asbestos-containing materials are identified on the floor plans provided in Appendix A.

If any materials which may contain asbestos and which were not tested during the course of the asbestos survey are discovered during any construction activities, the work shall not proceed until such time as the required notifications have been made and an appropriate course of action is determined.

Confirmatory testing of any such materials could be undertaken as the need arises (i.e., at the time of renovations, modifications, or demolition). Alternatively, the materials can conservatively be assumed to contain asbestos based on findings in adjacent areas.

Results of historical analyses of bulk samples for asbestos content are included in Appendix C. We have included in Appendix D for reference, background information regarding asbestos, and applicable regulations for control of exposure to asbestos

Table 5.1 Summary of Asbestos-Containing Materials

Level	Room	Material	Asbestos Content	Location Within Space	Friable or Non-Friable	Condition
1	101	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls and Ceiling	Non-Friable	G
1	102	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls and Ceiling	Non-Friable	G
1	103	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls and Ceiling	Non-Friable	G
1	103A	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls and Ceiling	Non-Friable	G
1	103B	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls and Ceiling	Non-Friable	G
1	103C	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls and Ceiling	Non-Friable	G
1	103C	12" x 12" Vinyl Floor Tile	3.1% Chrysolite ⁽¹⁾	Floor	Non-Friable	G
1	105	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Upper Wall	Non-Friable	G
1	105	Thermal Insulation	Assumed Asbestos	Piping	Friable	G
1	105A	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls and Ceiling	Non-Friable	G
1	105B	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Pipe Chase and Ceiling	Non-Friable	G
1	105C	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Ceiling	Non-Friable	G
1	106	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls at Stairs and Ceiling	Non-Friable	G
2	201	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls	Non-Friable	G
2	202	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls	Non-Friable	G
2	203	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls	Non-Friable	G
2	204	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls	Non-Friable	G

Level	Room	Material	Asbestos Content	Location Within Space	Friable or Non-Friable	Condition
2	205	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls and Ceiling	Non-Friable	G
2	206	Drywall Joint Compound	3.5% Chrysolite ⁽¹⁾	Walls	Non-Friable	G

NOTES:

(1) Chrysotile = Chrysotile asbestos.

Condition: G = Good.

F = Fair.

P = Poor.

6.0 USE AND LIMITATIONS OF THIS SUMMARY OF ASBESTOS-CONTAINING MATERIALS REPORT

This report, prepared for the City of Richmond Hill, does not provide certification or warranty, expressed or implied, that the review conducted by Haag Canada Inc. identified all asbestos-containing materials (as defined in the *Ontario Occupational Health and Safety Act*) at the subject facility. The work undertaken by Haag Canada Inc. was directed to provide information on the presence of asbestos-containing materials in building construction materials based on review of existing information, visual investigation of readily accessible areas of the building, and on the results of historical laboratory analysis of a limited number of bulk samples of material for asbestos.

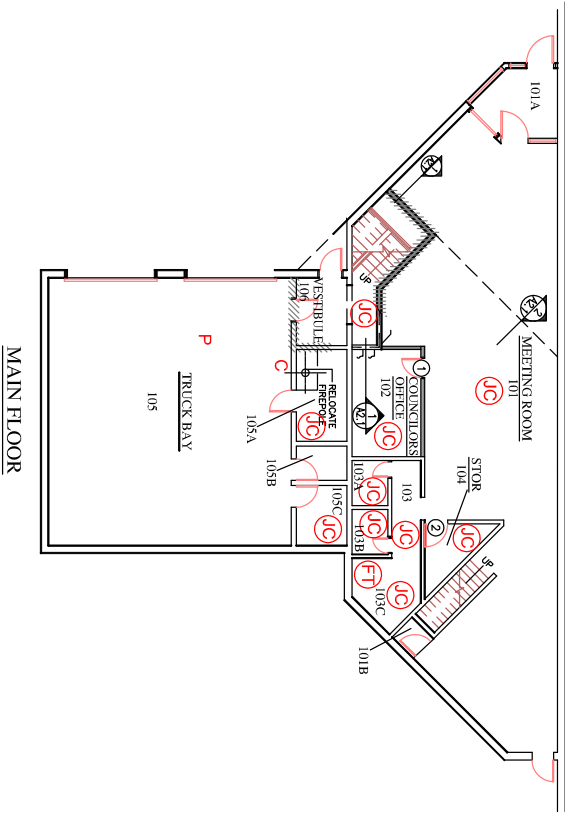
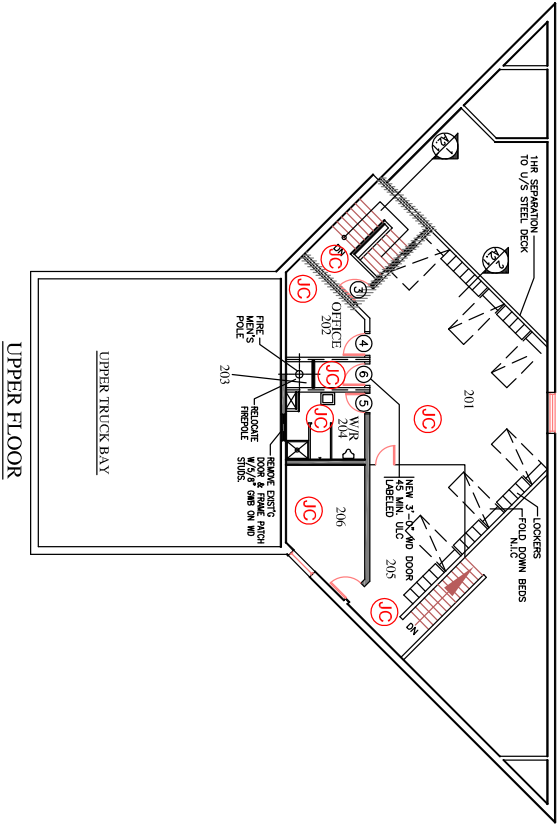
The material in this report reflects Haag Canada Inc.'s best judgment based on the information available at the time of the document review.

This report was prepared as part of the asbestos management program, not for the purposes of construction or renovation projects. Bulk sampling of building materials was carried out in accordance with the minimum sampling requirements specified in Table 1 of O.Reg. 278/05. We recommend that additional samples of certain types of material which may have been mixed on site at the time of construction (plaster, drywall joint compound, ceiling texture coat, etc.) be tested for asbestos content prior to the disturbance of these materials at the time of renovations, alterations, or demolition work.

This report is not intended to be used as a scope of work or technical specification for remediation of asbestos.

This engineering report has been written for the City of Richmond Hill's sole use and purpose, and only the City of Richmond Hill has the authority to distribute this report to any other person, firm, or corporation. Haag Canada Inc. and its agents and employees do not have and do disclaim any contractual relationship with, or duty or obligation to, any party other than the addressee of this report and the principals for whom the addressee is acting. Only the engineers who signed this document have the authority to change its contents and then only in writing to you. This report addresses the results of work completed to date. Should additional information become available, we reserve the right to amend, as warranted, any of our conclusions.

APPENDIX A: FLOOR PLANS



- JC Asbestos-Containing Drywall Joint Compound
- CP Assumed Asbestos-Containing Cement Pipe
- P Assumed Asbestos-Containing Thermal Insulation

APPENDIX B: ACTION/REVISION LOG

B. ACTION/REVISION LOG

Date of Action/Revision	Action/Revision
June 20, 2011	<i>"Town of Richmond Hill, Survey of Asbestos-Containing Building Materials Survey, Connor Building (82), Richmond Hill, Ontario,"</i> prepared by Decommissioning Consulting Services Limited (now Arcadis Canada Inc.).
December 13, 2021	<i>"Summary Of Asbestos-Containing Materials at the Connor Building (82), 39 King Road, Richmond Hill, Ontario",</i> prepared By Haag Canada Inc.

**APPENDIX C: RESULTS OF HISTORICAL ANALYSES OF BULK SAMPLES FOR ASBESTOS
CONTENT**

C.1 HISTORICAL RESULTS OF ANALYSES OF BULK SAMPLES FOR ASBESTOS CONTENT

Sample No.	Sample Location	Sample Description	Asbestos Content
1A-JC-105A	Room 105A	Drywall Joint Compound	3.5% Chrysotile ⁽¹⁾⁽²⁾
2A-VSF-204	Room 204	Vinyl Sheet Flooring, grey and white stone pattern	None Detected (PLM) None Detected (TEM) ⁽¹⁾⁽³⁾
2B-VSF-204	Room 204	Vinyl Sheet Flooring, grey and white stone pattern	None Detected ⁽¹⁾
2C-VSF-204	Room 204	Vinyl Sheet Flooring, grey and white stone pattern	None Detected ⁽¹⁾
3A-VFT-204	Room 204	12" x 12" Vinyl Floor Tile, white w/ grey specks	None Detected (PLM) None Detected (TEM) ⁽¹⁾⁽³⁾
3B-VFT-204	Room 204	12" x 12" Vinyl Floor Tile, white w/ grey specks	None Detected ⁽¹⁾
3C-VFT-204	Room 204	12" x 12" Vinyl Floor Tile, white w/ grey specks	None Detected ⁽¹⁾
4A-VFT-101	Room 101	12" x 12" Vinyl Floor Tile, dark grey w/ white and black specks	None Detected (PLM) None Detected (TEM) ⁽¹⁾⁽³⁾
4B-VFT-101	Room 101	12" x 12" Vinyl Floor Tile, dark grey w/ white and black specks	None Detected ⁽¹⁾
4C-VFT-101	Room 101	12" x 12" Vinyl Floor Tile, dark grey w/ white and black specks	None Detected ⁽¹⁾
5A-VFT-103C	Room 103C	12" x 12" Vinyl Floor Tile, white w/ heavy grey streaks	3.1% Chrysotile ⁽¹⁾⁽²⁾
6A-SCT-101	Room 101	2' x 4' Suspended Ceiling Tile, fissures in 2'	None Detected ⁽¹⁾
6B-SCT-101	Room 101	2' x 4' Suspended Ceiling Tile, fissures in 2'	None Detected ⁽¹⁾
6C-SCT-101	Room 101	2' x 4' Suspended Ceiling Tile, fissures in 2'	None Detected ⁽¹⁾

NOTES:

- (1) Sample result obtained from report titled "Town of Richmond Hill, Survey of Asbestos-Containing Building Materials Survey, Conner Building (82), Richmond Hill, Ontario," prepared by Decommissioning Consulting Services Limited (now Arcadis Canada Inc.), dated June 20, 2011.
- (2) Chrysotile = Chrysotile asbestos.
- (3) Bulk sample was analyzed by Polarized Light Microscopy (PLM) analysis, except where "TEM" is noted, in which case Transmission Electron Microscopy analysis was also performed.

APPENDIX D: REGULATORY DISCUSSION

D.1 APPLICABLE REGULATIONS - Ontario Regulation 278/05 - *Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations*

Control of exposure to asbestos is governed in Ontario by Regulation 278/05 – *Regulation respecting Asbestos on Construction Projects and in Buildings and Repair Operations* – made under the Occupational Health and Safety Act and prescribes certain requirements for management of asbestos. Disposal of asbestos waste (friable and non-friable materials) is governed by Ontario Regulation 278/05 and by Ontario Regulation 347, the general waste management regulation.

The Ontario *Occupational Health and Safety Act* requires that a list of all “designated substances” at a project site be provided to all bidders at the tendering stage and that the “Constructor” for a project shall ensure that each prospective contractor and subcontractor for the project has received a copy of the list before entering into a contract. Asbestos is one of the eleven substances classified as “designated substances” in Ontario.

Asbestos-containing material” is defined as material that contains 0.5% or more asbestos by dry weight.

The method and procedures for establishing whether material is asbestos-containing material and for establishing its asbestos content and the type of asbestos shall be in accordance with the following standard:

- U.S. Environmental Protection Agency. Test Method EPA/600/R-93/116: *Method for the Determination of Asbestos in Bulk Building Materials*. June 1993.

EPA Method 600 states that materials characterized by interfering binder/matrix, low asbestos content, and/or small fiber size may require additional sample treatment(s) and analysis performed beyond routine polarized light microscopy (PLM) analysis. The sample treatment required may include acid dissolution or ashing. Transmission electron microscopy (TEM) analysis may be required for detection of thin diameter fibres in certain materials (e.g., vinyl flooring materials). Point counting procedures may also be required in order to achieve prescribed detection limits.

O.Reg. 278/05 classifies asbestos work operations into three types (Type 1, 2 and 3), and specifies procedures to be followed in conducting asbestos abatement work.

O. Reg. 347 – General Waste Management – under the Environmental Protection Act, 19 as amended by O. Reg. 509/21, June 30, 2021, states the “Asbestos Waste” means the following solid or liquid waste that contains asbestos in more than a trivial amount:

- waste that results from the removal of asbestos-containing construction or insulation materials.
- waste that results from the manufacture of asbestos-containing products.
- waste that results from the removal of asbestos-containing components from a motor vehicle.
- waste that results from the removal or handling of waste or materials described above, including personal protective equipment, tools that cannot be decontaminated and cleaning materials.

APPENDIX

F2 DESIGNATED SUBSTANCES



Asbestos Sampling
Assessment Report,
WSP Canada Inc.
February 9, 2023



February 9, 2023

City of Richmond Hill
225 East Beaver Creek Road
Richmond Hill, ON

Attention: Paul Didzbalis

**Subject: Asbestos Sampling Assessment Report
Connor Building, 39 King Road, Richmond Hill, Ontario**

WSP Canada Inc. is pleased to provide this report detailing the results of the Asbestos Sampling Assessment of suspected asbestos-containing thermal insulation identified in the wall spaces beneath drywall walls at the Connor Building, located at 39 King Road, in Richmond Hill, Ontario. WSP's walkthrough and sampling was conducted on January 31st, 2023.

Please do not hesitate to contact the undersigned should you have any questions or require any further assistance.

Yours truly,

WSP Canada Inc.

A handwritten signature in blue ink, reading 'Shelby McCullough'.

Shelby McCullough, EPT
Project Coordinator, EHS Compliance

A handwritten signature in blue ink, reading 'Conrad Goericke'.

Conrad Goericke, C.E.T., EP
Senior Project Manager, Environment

Attachments

Appendix A – Site Photographs

Appendix B – Analytical Results

Appendix C – Asbestos-Containing Material Evaluation Criteria

Appendix D – Glossary of Terms

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Thornhill, ON, Canada L3T 0A1

Tel.: +1 905 882-1100
Fax: +1 905 882-0055
wsp.com

BACKGROUND

WSP Canada Inc. (WSP) was retained to conduct Asbestos Sampling Assessment in order to determine the presence or absence of suspect asbestos-containing thermal insulation identified in the wall space beneath drywall walls at the Connor Building, located at 39 King Road, in Richmond Hill, Ontario (the “subject building”).

WSP’s walkthrough and sampling was conducted on January 31st, 2023. It was requested in support of management and planning purposes and in order to satisfy the requirements of *Ontario Regulation 278/05 (O. Reg. 278/05)*.

SCOPE OF WORK

WSP conducted the Asbestos Sampling Assessment for suspect materials identified in support of management and planning purposes. Important details about these materials are documented as part of the assessment, including information such as their respective locations, and concentrations. It is mandatory that building personnel, or contractors hired to undertake work within the building, must be provided with the building’s Designated Substances report so that they can take the appropriate steps required to minimize potential exposures to these substances.

WSP’s scope of work for this project consisted of:

- A brief review of any existing asbestos and/or Designated Substances and hazardous materials survey reports or other relevant environmental reports for the subject building, if any.
- Collection of bulk samples from building materials suspected to contain asbestos and lab analysis via polarized light microscopy (PLM) according to US EPA Method 600/R-93/116.
 - Sampling was limited to the materials identified within the wall space.
 - Sampling was carried out throughout the entirety of the subject building to verify the specific locations of the suspect asbestos-containing insulation.
 - Every effort was made to select inconspicuous areas for sampling of suspect materials, and to minimize damage caused to the materials.
- Visual identification of other Designated Substances and hazardous materials were noted, if observed.
- Preparation of a report documenting the survey’s findings including types, locations and condition of materials identified, and recommendations for compliance and/or removal and repair, if necessary.

METHODOLOGY

ASBESTOS SURVEY METHODOLOGY

The assessment included the identification of potentially friable and non-friable asbestos-containing materials (ACM) within the subject areas. Asbestos means any of the following fibrous silicates: actinolite, amosite, anthophyllite, chrysotile, crocidolite or tremolite. According to Ontario Regulation 278/05 (O. Reg. 278/05) entitled “Designated Substance – Asbestos on Construction Projects and in Buildings and Repair Operations”, the term ‘friable material’ is applied to a material that when dry, can be crumbled, pulverized or powdered with moderate hand pressure. Asbestos materials that are friable have a greater potential to release airborne asbestos fibres into the air when disturbed. Common friable asbestos-containing buildings materials used in the past include: sprayed fireproofing, stucco, texture coat, and thermal pipe and jacket insulation.

“Non-friable” materials are those materials which are not easily crumbled or pulverized by hand pressure, and whose asbestos fibres are less likely to be released into the air when disturbed, because they’re bound by resins, or cements. Common types of non-friable asbestos containing materials found in buildings include: vinyl floor tiles, gasket materials, asbestos cement (Transite™) pipe, Transite™ board and asbestos textiles. However, when damaged, deteriorated, or vigorously disturbed with power tools, the resulting dust/debris becomes highly friable.

Bulk samples were collected from “suspect materials” (i.e., materials known as having the potential to be asbestos-containing) and analyzed by a third-party laboratory for verification. Asbestos samples are collected by taking a small volume of material (approximately two square centimeters in size) from either intact building materials or where possible, from damaged areas. The collected bulk samples were sealed and then submitted to an accredited, independent laboratory for analysis (accompanied by a chain of custody form) of asbestos content via US EPA Method EPA/600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials in accordance with the requirements of O. Reg. 278/05.

The number of bulk samples required in order to establish whether a material is asbestos-containing in accordance with O. Reg. 278/05, is summarized in Table 1.

Table 1 Bulk Sample Requirements Under O. Reg. 278/05

TYPE OF MATERIAL	QUANTITY	MINIMUM NUMBER OF BULK SAMPLES
Surfacing material, including without limitation material that is applied to surfaces by spraying, by troweling or otherwise, such as acoustical plaster on ceilings, fireproofing materials on structural members and plaster	Less than 90 m ²	3
	90 m ² or more, but less than 450 m ²	5
	450 m ² or more	7
Thermal insulation, except as described below	Any size	3
Thermal insulation patch	Less than 2m or 0.5 m ²	1
Other material	Any size	3

In accordance with O. Reg. 278/05 and laboratory analytical methods, the following considerations are also necessary for handling/analyzing bulk material samples:

- For layered materials, each individual or discrete layer sampled or observed by the laboratory during analysis, is treated as a discrete sample; and
- If a bulk sample is found to contain greater than 0.5% asbestos (by dry weight), additional bulk samples from the same material are not required to be analyzed (“Stop-Positive” analysis), and the entire area of homogenous material from which the bulk sample was collected is deemed to asbestos-containing material.

ADDITIONAL REGULATORY REQUIREMENTS FOR ASBESTOS

Among the Designated Substances, asbestos is unique in that it is governed by two regulations under the Occupational Health and Safety Act - one for the general mining and processing operations involving asbestos, and one for asbestos on construction projects, and in buildings and repair operations.

Ontario Regulation 490/09 (O. Reg. 490/09), made under the Act, entitled “Designated Substances”, came into effect on July 1, 2010, applies mainly to workers engaged in mining, processing, or manufacturing asbestos products, and repairing, altering and maintaining machinery and equipment containing asbestos.

Ontario Regulation 278/05 (O. Reg. 278/05), made under the Act, entitled “Designated Substance – Asbestos on Construction Projects and in Buildings and Repair Operations” came into effect on November 1, 2005, with some sections contained therein becoming effective on November 1, 2007. This regulation revoked and replaced the previous asbestos regulation, O. Reg. 838/90.

OBSERVATIONS AND RESULTS

DESIGNATED SUBSTANCES AND HAZARDOUS MATERIALS

It should be noted that additional asbestos-containing materials (ACM), Designated Substances or hazardous materials (DSHM) may be concealed by existing building finishes, components or fixtures, and were not accessible during the time of this assessment. If demolition or construction activities uncover materials suspected to contain asbestos, lead, other DSHM, all work must stop prior to the disturbance of these materials, and the suspect materials should either be sampled by a qualified person, or presumed to contain the suspected substance. Whether the suspect material(s) are confirmed, or presumed, to contain these substances, they must be handled and disposed of in accordance with the appropriate and applicable guidelines and regulations including, but not limited to: *O. Reg. 278/05*, *O. Reg. 490/09* and *R.R.O. 1990, Regulation 347* (as amended).

ASBESTOS-CONTAINING MATERIALS

In accordance with the requirements stipulated in *O. Reg. 278/05*, homogenous materials (i.e., materials uniform in color and texture) must be considered to be asbestos-containing, if any sample which is collected from that homogeneous material, is identified to have an asbestos concentration of 0.5% or greater by dry weight.

A total of six (6) samples were collected from two (2) homogenous building material. Table 2 below summarizes all materials which were sampled as a part of this assessment.

Table 2 Summary of Bulk Asbestos Sample Results

SAMPLE ID	LOCATION	SAMPLE DESCRIPTION	FRIABLE/NON-FRIABLE	ASBESTOS CONTENT (%)
AS 1-1 to 1-3	Wall Space – 2 nd Floor	Thermal Fibreglass Insulation	Friable	None Detected
AS 2-1 to 2-3	Wall Space – Ground Floor	Thermal Fibreglass Insulation	Friable	None Detected

Notes: 1. For further details, refer to Appendix B – Analytical Results.
2. Refer to Appendix C – Asbestos-Containing Material Evaluation Criteria for details.

Based on the laboratory results, the samples collected were not considered to be asbestos-containing, as defined by *O. Reg. 278/05* (i.e., a material that contains 0.5% or more asbestos by dry weight).

LIMITATIONS

WSP Canada Inc. (“WSP”) prepared this report solely for the use of the intended recipient in accordance with the professional services agreement between the parties. In the event a contract has not been executed, the parties agree that the WSP General Terms for Consultant shall govern their business relationship which was provided to you prior to the preparation of this report.

The report is intended to be used in its entirety. No excerpts may be taken to be representative of the findings in the assessment.

The conclusions presented in this report are based on work performed by trained, professional and technical staff, in accordance with their reasonable interpretation of current and accepted engineering and scientific practices at the time the work was performed.

The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by WSP and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial and physical constraints applicable to this project.

WSP disclaims any obligation to update this report if, after the date of this report, any conditions appear to differ significantly from those presented in this report; however, WSP reserves the right to amend or supplement this report based on additional information, documentation or evidence.

WSP makes no other representations whatsoever concerning the legal significance of its findings.

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In preparing this report, WSP has relied in good faith on information provided by others, as noted in the report. WSP has reasonably assumed that the information provided is correct and WSP is not responsible for the accuracy or completeness of such information.

Benchmark and elevations used in this report are primarily to establish relative elevation differences between the specific testing and/or sampling locations and should not be used for other purposes, such as grading, excavating, construction, planning, development, etc.

WSP disclaims any responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions /or costs.

Design recommendations given in this report are applicable only to the project and areas as described in the text and then only if constructed in accordance with the details stated in this report. The comments made in this report on potential construction issues and possible methods are intended only for the guidance of the designer. The number of testing and/or sampling locations may not be sufficient to determine all the factors that may affect construction methods and costs. We accept no responsibility for any decisions made or actions taken as a result of this report unless





we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

Overall conditions can only be extrapolated to an undefined limited area around these testing and sampling locations. The conditions that WSP interprets to exist between testing and sampling points may differ from those that actually exist. The accuracy of any extrapolation and interpretation beyond the sampling locations will depend on natural conditions, the history of Site development and changes through construction and other activities. In addition, analysis has been carried out for the identified chemical and physical parameters only, and it should not be inferred that other chemical species or physical conditions are not present. WSP cannot warrant against undiscovered environmental liabilities or adverse impacts off-Site.

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These limitation statements are considered an integral part of this report.

PHOTO NO.	MATERIAL DESCRIPTION & LOCATION	PHOTO
<u>1</u>	<p>Representative photo of the thermal fibreglass insulation identified in the wall space beneath drywall walls on the 2nd floor of the subject building. This material <u>is not</u> considered asbestos-containing.</p> <p><u>Sample ID:</u> AS 1-1 to 3</p>	
<u>2</u>	<p>Representative photo of the thermal fibreglass insulation identified in the wall space beneath drywall walls on the ground floor of the subject building. This material <u>is not</u> considered asbestos-containing.</p> <p><u>Sample ID:</u> AS 2-1 to 3</p>	



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EMSL Canada Order 552301374
Customer ID: 55SPLC25
Customer PO: 221-04676-00
Project ID:

Attn: Conrad Goericke
WSP Canada, Inc.
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Phone: (416) 798-0065
Fax:
Collected: 1/31/2023
Received: 1/31/2023
Analyzed: 2/07/2023

Proj: Richmond Hill - Conner Building # 221-04676-00, Phase 30, Sub-phase 2?

Summary Test Report for Asbestos Analysis of Bulk Materials for Ontario Regulation 278/05

Client Sample ID: AS1-1 **Lab Sample ID:** 552301374-0001
Sample Description: Fibreglass Insulation/ 2nd Floor

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	2/07/2023	Pink	80.0%	20.0%	None Detected	

Client Sample ID: AS1-2 **Lab Sample ID:** 552301374-0002
Sample Description: Fibreglass Insulation/ 2nd Floor

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	2/07/2023	Pink	80.0%	20.0%	None Detected	

Client Sample ID: AS1-3 **Lab Sample ID:** 552301374-0003
Sample Description: Fibreglass Insulation/ 2nd Floor

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	2/07/2023	Pink	80.0%	20.0%	None Detected	

Client Sample ID: AS2-1 **Lab Sample ID:** 552301374-0004
Sample Description: Fibreglass Insulation/ Ground Floor

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	2/07/2023	Pink	80.0%	20.0%	None Detected	

Client Sample ID: AS2-2 **Lab Sample ID:** 552301374-0005
Sample Description: Fibreglass Insulation/ Ground Floor

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	2/07/2023	Pink	70.0%	30.0%	None Detected	

Client Sample ID: AS2-3 **Lab Sample ID:** 552301374-0006
Sample Description: Fibreglass Insulation/ Ground Floor

TEST	Analyzed Date	Color	Non-Asbestos		Asbestos	Comment
			Fibrous	Non-Fibrous		
PLM	2/07/2023	Pink	80.0%	20.0%	None Detected	



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EMSL Canada Order 552301374
Customer ID: 55SPLC25
Customer PO: 221-04676-00
Project ID:

Summary Test Report for Asbestos Analysis of Bulk Materials for Ontario Regulation 278/05

Analyst(s):

Ashley Brito PLM (4)
Kira Ramphal PLM (2)

Reviewed and approved by:

Matthew Davis or other approved signatory
or Other Approved Signatory

None Detected = <0.1%. EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This is a summary report; official reports are available on LabConnect or upon request and relates only to the samples reported above, and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. Results are generated from the field sampling data (sampling volumes and areas, locations, etc.) provided by the client on the Chain of Custody. Samples are within quality control criteria and met method specifications unless otherwise noted. The above analyses were performed in general compliance with Appendix E to Subpart E of 40 CFR (previously EPA 600/M4-82-020 "Interim Method") but augmented with procedures outlined in the 1993 ("final") version of the method. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST or any agency of the federal government. Non-friable organically bound materials present a problem matrix and therefore EMSL recommends gravimetric reduction prior to analysis. Unless requested by the client, building materials manufactured with multiple layers (i.e. linoleum, wallboard, etc.) are reported as a single sample. Estimation of uncertainty is available on request.

Samples analyzed by EMSL Canada Inc. Mississauga, ON NVLAP Lab Code 200877-0

Initial report from: 02/07/2023 13:31:15

ASBESTOS-CONTAINING MATERIAL EVALUATION CRITERIA

A description of the criteria used in evaluating the condition, accessibility and exposure risk of asbestos-containing materials (ACM) is provided below.

ASSESSMENT OF CONDITION

SPRAY-APPLIED FIREPROOFING, INSULATION AND TEXTURED FINISHES

In evaluating the condition of ACM spray applied as fireproofing, thermal insulation or texture, decorative or acoustic finishes, the following criteria apply:

Good

Surface of material shows no significant signs of damage, deterioration or delamination. Up to one percent visible damage to surface is allowed within range of GOOD. Evaluation of sprayed fireproofing requires the Assessor to be familiar with the irregular surface texture typical of sprayed asbestos products. GOOD condition includes un-encapsulated or unpainted fireproofing or texture finishes, where no delamination or damage is observed, and encapsulated fireproofing or texture finishes where the encapsulation has been applied after the damage or fallout occurred.

Poor

Sprayed materials show signs of damage, delamination or deterioration. More than one percent damage to surface of ACM spray. In observation areas, where damage exists in isolated locations, both GOOD and POOR condition may be reported. The extent or percentage of each condition will be recorded on the Assessor reassessment form.

Fair

Condition is not utilized or considered as a valid criterion in the evaluation of sprayed fireproofing, sprayed insulation, or texture coat finishes.

The evaluation of ACM spray applied as fireproofing, non-mechanical thermal insulation, or texture, decorative or acoustic finishes which are present above ceilings, may be limited by the number of observations made, and by building components such as ducts or full height walls that obstruct the above ceiling observations. Persons entering the ceiling area are advised to be watchful for ACM DEBRIS prior to accessing or working above ceilings in areas of building with ACM, regardless of the reported condition.

OTHER ACM

In evaluating the condition of mechanical insulation (on boilers, breaching, ductwork, piping, tanks, equipment etc.) the following criteria are used:

Good

Insulation is completely covered in jacketing and exhibits no evidence of damage or deterioration. No insulation is exposed. Includes conditions where the jacketing has minor surface damage (i.e., scuffs or stains), but the jacketing is not penetrated.

Fair

Minor penetration damage to jacketed insulation (cuts, tears, nicks, deterioration or delamination) or undamaged insulation that has never been jacketed. Insulation is exposed but not showing surface disintegration. The extent of missing insulation ranges should be minor to none.

Poor

Original insulation jacket is missing, damaged, deteriorated or delaminated. Insulation is exposed and significant areas have been dislodged. Damage cannot be readily repaired. The evaluation of mechanical insulation may be limited by the number of observations made and building components such as ducts or full height walls that obstruct observations. In these circumstances, it is not possible to observe each foot of mechanical insulation from all angles.

NON-FRIABLE AND POTENTIALLY FRIABLE MATERIALS

Non-friable materials generally have little potential to release airborne fibres, even when damaged by mechanical breakage. However, some non-friable materials, i.e., exterior asbestos cement products, may have deteriorated so that the binder no longer effectively contains the asbestos fibres. In such cases of significantly deteriorated non-friable material, the material will be treated as a friable product.

EVALUATION OF ACCESSIBILITY

The accessibility of building materials known or suspected of being ACM is rated according to the following criteria:

Access (A)

Areas of the building within reach of all building users. Includes areas such as gymnasiums, workshops, and storage areas where activities of the building users may result in disturbance of ACM not normally within reach from floor level.

Access (B)

Frequently entered maintenance areas within reach of maintenance staff, without the need for a ladder. Includes: frequently entered pipe chases, tunnels and service areas or areas within reach from a fixed ladder or catwalk, i.e., tops of equipment, mezzanines.

Access (C) Exposed

Areas of the building above 8'0" where use of a ladder is required to reach the ACM. Only refers to ACM materials that are exposed to view, from the floor or ladder, without removing or opening other building components such as ceiling tiles, or service access doors or hatches. Does not include infrequently accessed service areas of the building.

Access (C) Concealed

Areas of the building which require the removal of a building component, including lay-in ceilings and access panels into solid ceiling systems. Includes rarely entered crawl spaces, attic spaces, etc. Observations are limited to the extent visible from the access points.

Access (D)

Areas of the building behind inaccessible solid ceiling systems, walls, or mechanical equipment, etc. where demolition of the ceiling, wall or equipment, etc., is required to reach the ACM. Evaluation of the condition and extent of ACM is limited or impossible, depending on the Assessor's ability to visually examine the materials in Access D.

DEFINITION OF ACTION LEVELS

Based on the results of the inspection and bulk sample analysis of samples collected and submitted for testing, recommendations were provided for compliance with regulation. These include assigned "Action Levels" to assist in the prioritization of corrective measures. The Action Matrix provided below establishes the recommended asbestos control action. The measures that are to be taken for each "Action Level" are described in full following the matrix.

ACM ACTION TABLE

ACCESS	CONDITION			DEBRIS
	Good	Fair	Poor	
(A)	ACTION 5/7 ¹	ACTION 5/6 ²	ACTION 3	ACTION 1
(B)	ACTION 7	ACTION 6/5 ³	ACTION 3	ACTION 1
(C) exposed	ACTION 7	ACTION 6	ACTION 4	ACTION 2

CONDITION

ACCESS	Good	Fair	Poor	DEBRIS
(C) concealed	ACTION 7	ACTION 6	ACTION 4	ACTION 2
(D)	ACTION 7	ACTION 7	ACTION 7	ACTION 7
<ol style="list-style-type: none"> 1. If material in ACCESS (A)/GOOD condition is not removed ACTION 7 is required. 2. If material in ACCESS (A)/FAIR condition is not removed ACTION 6 is required. 3. Remove ACM in ACCESS (B)/FAIR condition if ACM is likely to be disturbed. 4. Suspect ACM are to comply with ACTION 8 requirements. 				

Description of Actions

ACTION LEVEL	REQUIRED ACTION
“ACTION 1”	<p><i>Immediate Clean-Up of Debris that is Likely to Be Disturbed</i></p> <p>Restrict access that is likely to cause a disturbance of the ACM DEBRIS and clean up ACM DEBRIS immediately. Utilize correct asbestos procedures. This action is required for compliance with regulatory requirements. The surveyor will immediately notify the owner of this condition.</p>
“ACTION 2”	<p><i>Type 2 Precautions for Entry into Areas with ACM DEBRIS</i></p> <p>At locations where ACM DEBRIS can be isolated in lieu of removal or cleaned up, use appropriate means to limit entry to the area. Restrict access to the area to persons utilizing Type 2 asbestos precautions. The precautions will be required until the ACM DEBRIS has been cleaned up, and the source of the DEBRIS has been stabilized or removed.</p>
“ACTION 3”	<p><i>ACM Removal Required for Compliance</i></p> <p>Remove ACM for compliance with regulatory requirements. Utilize asbestos procedures appropriate to the scope of the removal work.</p>
“ACTION 4”	<p><i>Type 2 Precautions for Access into Areas Where ACM is Present & Likely to be Disturbed by Access</i></p> <p>Use Type 2 asbestos precautions when entry or access into an area is likely to disturb the ACM. ACTION 4 must be used until the ACM is removed (Use ACTION 1 or 2 if DEBRIS is present).</p>
“ACTION 5”	<p><i>Proactive ACM Removal</i></p> <p>Remove ACM in lieu of repair, or at locations where the presence of asbestos in GOOD condition is not desirable.</p>



ACTION LEVEL	REQUIRED ACTION
“ACTION 6”	<p><i>ACM Repair</i></p> <p>Repair ACM found in FAIR condition, and not likely to be damaged again or disturbed by normal use of the area or room. Upon completion of the repair work, treat ACM as material in GOOD condition and implement ACTION 7. If ACM is likely to be damaged or disturbed, during normal use of the area or room, implement ACTION 5.</p>
“ACTION 7”	<p><i>Asbestos Management Program with Routine Surveillance</i></p> <p>Implement an Asbestos Management Program, including routine surveillance of ACM. Trained workers or contractors must use appropriate asbestos precautions (Type 1, Type 2 or Type 3) during disturbance of the remaining ACM.</p>
“ACTION 8”	<p><i>Suspect Materials</i></p> <p>Implement the Asbestos Management Program for building materials that historically contained asbestos but cannot, or have not, been sufficiently tested for asbestos content. These materials are identified as SUSPECT MATERIALS.</p>

GLOSSARY OF TERMS

Accessibility: The terms easily accessible, less accessible, and inaccessible are used to describe the ease with which asbestos can be accessed by tenants, the public, employees and contractors in the building. **Easily accessible** indicates that ACM is visible from the floor and can be touched by building occupants, and therefore has a potential for significant damage. **Less accessible** indicates that ACM is not visible from the floor, or if it is visible, it is high enough not to be touched by building occupants, and has a potential for damage. **Inaccessible** indicates that ACM is located behind masonry, drywall, or other types of solid enclosures and is only accessible after destruction of the enclosure, and has a low potential for damage.

ACM: Asbestos-Containing Material. A material that contains greater than 0.5% asbestos by dry weight as per Ontario Regulation 278/05 and is used to refer to the vastly different types of such material.

Amosite: The technical name for ‘brown’ asbestos.

AMP: Asbestos Management Plan

Asbestos: A group of naturally occurring fibrous minerals with current or historical commercial usefulness due to their extraordinary tensile strength, poor heat conduction, and relative resistance to chemical attack.

Asbestos Abatement: Procedures to control fiber release from asbestos-containing materials in a building or to remove them entirely, including removal, encapsulation, repair, enclosure, encasement, and operations and maintenance programs.

Asbestos Cement: A hard product that contains up to 15% asbestos fibres which can be any of the three main types. This is a relatively safe material provided it remains intact as the cement binds the asbestos fibres; breakage will lead to fibre release. Often referred to by the trade name Transite™.

Asbestos Control: Minimizing the generation of airborne asbestos fibres until a permanent solution is developed.

Asbestos Debris: Pieces of an ACM that can be identified by color, texture, or composition, or means dust, if the dust is determined by an accredited inspector to be ACM.

Asbestos Fibres: Fibres with their length being greater than five microns (length to width ratio of 3:1), generated from an asbestos-containing material.

BAS: Building Asbestos Supervisor.

Bulk Sample: A sample of material such as boarding, insulation or debris taken by an accredited surveyor to be tested for asbestos fibre content by an accredited laboratory.

Chrysotile: The technical name for ‘white’ asbestos.

Condition: The condition of ACM is described using the designations: good, fair and poor. **Good** refers to ACM with no visible damage or deterioration, or showing only very limited damage or deterioration. **Fair** refers to ACM with some damage or deterioration (less than 10% of the material). **Poor** refer to ACM that is significantly damaged or deteriorated (at least 10% of the material).

Crocidolite: The technical name for ‘blue’ asbestos.

Designated Substances Regulations: A series of Regulations made by the Ministry of Labour, Immigration, Training, and Skills Development under the Occupational Health and Safety Act. The regulations provide management protocols and guidelines to the following eleven substances: acrylonitrile, arsenic, asbestos, benzene, coke oven emissions, ethylene oxide, isocyanates, lead, mercury, silica and vinyl chloride.

Demolition: Complete dismantling or the complete or partial destruction of a building, structure, ship or plant such that it cannot be used in that form again.

Friable ACM: Any material that contains more than 0.5% asbestos by weight and can be crumbled, pulverized, or reduced to powder by the pressure of an ordinary human hand.

HEPA Filter: High Efficiency Particulate Air Filter.

Homogeneous Area: Defined by the US EPA as containing material that is uniform in texture and appearance, was installed at one time and is unlikely to consist of more than one type or formulation of material.

Major Action: All response actions requiring Type 3 ACM Removal Procedures, or Type 2 Removal Procedures involving the removal of friable ACM and provisions of an enclosure.

Management Assessment: A assessment carried out without disturbing any part of the fabric, components or finishes. Samples may be taken.

MLITSD: Ministry of Labour, Immigration, Training and Skills Development.

O&M: Operations and Maintenance Program.

O. Reg.: Ontario Regulations.

Non-Friable ACM: Any material that contains more than 0.5% asbestos by weight but cannot be pulverized under hand pressure.

PACM: Presumed Asbestos-Containing Materials. All thermal system insulation, surfacing material and asphalt/vinyl flooring in a building constructed prior to 1981 that has not been appropriately tested are presumed asbestos-containing materials.

PPE: Personal Protective Equipment such as overalls, masks, gloves etc.

Pre-Demolition Assessment: A assessment similar to the Project-Specific Assessment but also includes test cuts into solid building systems and destructive testing to inspect concealed building finishes/spaces for DSHM.

Project Specific Assessment: An assessment that is completed in support of a specific renovation or maintenance project. Bulk samples are collected of building materials suspected to contain DSHM including asbestos.

RPE: Respiratory Protective Equipment. The different types of face masks worn appropriate to the risk. Where the risk assessment shows that the Control Limit will be exceeded RPE must be worn.

Surveyor/Assessor: Any person who provides professional health and safety services relating to asbestos-containing construction material. The activities of a surveyor/assessor include building inspection, abatement project design, project administration, sample collection, preparation of asbestos management plans, clearance monitoring, and supervision of site surveillance technicians.

Type 1: Asbestos Abatement Operation with ACM as an operation described by O. Reg. 278/05 in subsection 12 (2), generally an operation that does not cause asbestos fibres to become airborne.

Type 2: Asbestos Abatement Operation with ACM as an operation described by O. Reg. 278/05 in subsection 12 (3), generally a major operation with limited scope of work.

Type 3: Asbestos Abatement Operation with ACM as an operation described by O. Reg. 278/05 in subsection 12 (4), generally a major operation.

APPENDIX

G1 GEOTECHNICAL REPORT

A Geotechnical Investigation
for Proposed Building
Redevelopment,
Soil Engineers Ltd., May 2023



Soil Engineers Ltd.

CONSULTING ENGINEERS

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**A REPORT TO
CITY OF RICHMOND HILL**

**A GEOTECHNICAL INVESTIGATION
FOR PROPOSED BUILDING REDEVELOPMENT**

**39 KING ROAD
CITY OF RICHMOND HILL**

REFERENCE NO. 2207-S017

**MAY 2023
(REVISION OF REPORT DATED SEPTEMBER 2022)**

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1.0 **INTRODUCTION**

In accordance with an initial Purchase Orders 4550000315 dated July 5, 2022 and 4550000415, dated April 11, 2023 from the City of Richmond Hill, a geotechnical investigation was conducted at 39 King Road in the City of Richmond Hill.

An initial geotechnical investigation was performed at 39 King Road in November 2022 and the proposed development plan has been revised; accordingly a supplementary investigation is carried out for the proposed building addition on the east side of the existing building.

The purpose of the investigation was to reveal the subsurface conditions and determine the engineering properties of the disclosed soils for the proposed facility. The geotechnical findings and resulting recommendations are presented in this Report.

2.0 **SITE AND PROJECT DESCRIPTION**

The City of Richmond Hill is situated on Halton till plain where glacial tills are overridden and interstratified by glaciolacustrine sand, silt and clay deposits. The sand and silt strata are likely to be part of the confined aquifer which is known to occur in the region. In places, the aquifer is under artesian pressure.

The subject property is located at 39 King Road in the City of Richmond Hill. The site is currently occupied by an existing building, a bocce court, with associated underground septic storage tank, surface tile bed, landscaping, access driveway and parking area. A watercourse runs along the northern boundary of the property.

A review of the proposed concept plan provided by the City of Richmond Hill indicates that the bocce court and the septic system will be removed to make way for a new parking area with covered storage bins for landscape supplies. The existing driveway and parking area will be reconfigured. In addition, there will be a building addition on the east side of the existing building.

3.0 **FIELD WORK**

The initial field work, consisting of seven (7) sampled boreholes extending to the depth of 6.6 m from the prevailing ground surface, was performed on July 21, 2022. The supplementary field work, consisting of two (2) boreholes, extending to the depth of 6.6 m was performed on April 25, 2023. The boreholes were illustrated on Drawing No. 1. To



differentiate from the initial boreholes, the supplementary boreholes are labelled in the 100-series.

The boreholes were advanced at intervals to the sampling depths by track-mounted, continuous-flight power-auger machines equipped for soil sampling. Standard Penetration tests, using the procedures described on the enclosed “List of Abbreviations and Terms”, were performed at the sampling depths. The test results are recorded as the Standard Penetration Resistance (or ‘N’ values) of the subsoil. The relative density of the non-cohesive strata and the consistency of the cohesive strata are inferred from the ‘N’ values. Split-spoon samples were recovered for soil classification and laboratory testing.

The field work was supervised and the findings recorded by a Geotechnical Technician. The ground elevations at Boreholes 1 to 7 were obtained using a hand-held Global Navigation Satellite System (GNSS) equipment. The elevations at Boreholes 101 and 102 were surveyed with reference to the ground elevation of Borehole 6.

4.0 **SUBSURFACE CONDITIONS**

The boreholes were drilled on the pavement, landscape area and around the existing building. The investigation has disclosed that beneath the pavement structure, a topsoil veneer, a layer of earth fill and alluvium in places, the site is underlain by strata of sand, silt and sandy silt till.

Detailed descriptions of the subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 9, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2. The engineering properties of the disclosed soils are discussed herein.

4.1 **Topsoil** (Except Boreholes 1 and 7)

The revealed topsoil near the ground surface of the borehole locations is approximately 8 to 41 cm in thickness. Thicker topsoil layer may be contacted in areas beyond the borehole locations.

4.2 **Pavement Structure** (Boreholes 1 and 7)

Boreholes 1 and 7 were carried out on the paved parking lot and the driveway, which consists of 100 mm and 51 mm thick asphaltic concrete, overlying a layer of granular fill with 130 mm and 76 mm in thickness, respectively.



4.3 **Earth Fill** (All boreholes)

A layer of earth fill was contacted below the topsoil and pavement structure in all boreholes, extending to 1.0 to 4.6 m below the ground surface. The fill consists of a mixture of sand, silt and clay, with crushed stones, topsoil and organic inclusions and peat layer in places.

The natural water content values of the fill samples range from 2% to 56%, with a median of 17%, showing damp to very moist conditions; the high water content value is due to the presence of organic and peat inclusions.

The obtained 'N' values range from 0 to 19, with a median of 6 blows per 30 cm of penetration, showing that the fill was loosely placed without quality control.

One must be aware that the samples retrieved from the borehole may not be truly representative of the geotechnical and environmental quality of the earth fill. The extent of the fill and the quality of the fill can be assessed by laboratory testing and/or test pits if necessary.

4.4 **Alluvium** (Boreholes 3 and 7)

Alluvial deposit was contacted in Boreholes 3 and 7, generally beneath the earth fill and extends to a depth 4.0 m from the prevailing ground surface. It consists of sand, silt and remnants of plant debris and shell fragments that could have been deposited on historical flood plain or wetland in the past. The natural water content values of the alluvium ranged from 18% to 37%. The higher water content may represent plant debris and organics in the deposit.

The alluvium is generally weak and will consolidate excessively under additional loads. It will generate volatile gases under anaerobic conditions.

4.5 **Sandy Silt Till** (All Boreholes)

The sandy silt till was contacted in all boreholes beneath the earth fill, alluvium, sand and silt. It extends to the termination depth of all the boreholes. It consists of a random mixture of particle sizes ranging from clay to gravel, with sand and silt being the dominant fraction. Sample examinations disclosed that the till is cemented and it displays a slight to some cohesion when remoulded, indicating that the clay content varies with depth in places. Grain size analyses were performed on three representative samples of the sandy silt till; the results are plotted in Figure 10.



The obtained 'N' values of the till samples range from 4 to 23, with a median of 12 blows per 30 cm of penetration, indicating that the till is loose to compact, generally compact in relative density.

The natural water content values of the till samples range from 9% to 21%, with a median of 13%, showing generally moist conditions. Higher moisture may represent higher clay content in the till deposit.

The engineering properties of the sandy silt till are listed below:

- Moderate high frost susceptibility and low water erodibility
- Low permeability, with an estimated coefficient of permeability of 10^{-6} cm/sec.
- The till will be relatively stable in steep excavation; however, the sand layers in the till deposit may slough after exposure for some time.
- A fair pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 7%.
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 5000 ohm·cm.

4.6 **Silt** (Boreholes 1, 2, 7 and 101)

The silt deposit was contacted in the vicinity of Boreholes 1, 2, 7 and 101, beneath the earth fill, alluvium or sandy silt till. It is very fine grained, containing various amount of clay. Grain size analyses were performed on two selected samples of the silt and the results are plotted on Figure 11 and 12.

The natural water content values of the samples were found to be 16% to 20%, showing that the silt is in very moist to wet conditions, displaying some dilatancy.

The obtained 'N' values are 6 to 16 blows per 30 cm of penetration, indicating that the silt is loose to compact in relative density.

The engineering properties of the silt deposit are given below:

- High frost susceptible, with high soil-adfreezing potential.
- High water erodibility, it is susceptible to migration through small opening under seepage pressure.
- Relatively pervious, with the estimated coefficient of permeability of 10^{-4} cm/sec.
- The soil has high capillarity and water retention capacity.



- In excavation, the moist silt will be stable; however, the wet silt may slough and run slowly with seepage bleeding from the cut face. It will boil with a piezometric head of 0.4 m.
- Poor pavement-supportive materials, with an estimated CBR value of 3% to 7%.
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 5000 ohm.cm.

4.7 **Sand** (Boreholes 1 and 101)

The sand was found beneath the earth fill in Borehole 1 and near the bottom of the borehole in Borehole 101. It is fine grained and silty in Borehole 1, and gravelly with some silt in Borehole 101. A grain size analysis was performed on one representative sample of the silty fine sand; the result is plotted in Figures 13.

The sand is generally wet, as confirmed by the natural water content values of 12% and 19%.

The obtained 'N' values of 10 and 18 blows per 30 cm of penetration indicates that the sand is generally compact in relative density.

The engineering properties of the sand deposit are presented below:

- High water erodibility and frost susceptibility, with high soil-adsfreezing potential.
- Pervious, with an estimated coefficient of permeability of 10^{-3} cm/sec.
- In excavation, the sand will be stable in a damp to moist condition, however, if it is wet, the sand will slough and run with seepage. It may boil under piezometric head of 0.3 m.
- A fair material to support pavement, with an estimated CBR value of 8%.
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 6000 ohm·cm.

4.8 **Interpretation of Dynamic Cone Penetration Test Result** (Borehole 1)

Dynamic cone penetration tests were performed beyond 6.6 m in Boreholes 1. The test results are plotted on the Logs of Boreholes, Figure 1. Although the tests extended to a depth of 10.5 m, the soil condition appears to only improve marginally.



4.9 **Compaction Characteristics of the Revealed Soils**

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied. As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table 1.

Table 1 - Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Earth Fill	2 to 56	12 to 15	10 to 18
Sandy Silt Till	9 to 21	12	8 to 15
Silt	16 to 20	13	9 to 17
Sand	12 and 19	11	6 to 16

The earth fill must be sorted free of topsoil inclusions and deleterious materials prior to its use as structural backfill. Otherwise, it must be properly disposed of off site. The organic-free earth fill and in situ soils that are too wet will require aeration prior to structural compaction. Aeration of the wet soils can be effectively carried out by spreading them thinly on the ground in dry and warm weather.

Alluvium should not be reused for backfilling due to its compressibility and organic content.

5.0 **GROUNDWATER CONDITION**

The boreholes were checked for the presence of groundwater upon completion of drilling. The data are plotted on the Borehole Logs and summarized in Table 2.

Table 2 - Groundwater Level

Borehole No.	Ground Elevation (m)	Measured Groundwater On Completion	
		Depth (m)	Elevation (m)
1	294.2	1.5	292.7
2	294.4	1.8	292.6
3	293.9	1.8	292.1

**Table 2 - Groundwater Level (cont'd)**

Borehole No.	Ground Elevation (m)	Measured Groundwater On Completion	
		Depth (m)	Elevation (m)
4	294.5	2.1	292.4
5	294.3	Below 6.6 m	Below 287.7
6	294.6	3.7	290.9
7	293.8	1.2	292.6
101	294.9	2.4	292.5
102	295.0	4.9	290.1

Upon the completion of drilling, groundwater was observed in the open boreholes in 8 of the 9 boreholes between depths of 1.2 m and 4.9 m, or El. 292.7 m and El. 290.1 m. The groundwater contacted in the boreholes are likely perched groundwater in the upper zone in the earth fill, sand and silt, as no groundwater was detected in Borehole 5, where it consists mostly of sandy silt till.

The groundwater level on site is influenced by the water level of the adjacent tributary of the Humber River and will be subject to seasonal fluctuations.

6.0 **DISCUSSION AND RECOMMENDATIONS**

The investigation has disclosed that beneath the pavement structure, a topsoil veneer, earth fill and/or alluvium, the site is underlain by strata of sand and silt over a deposit of sandy silt till.

Groundwater was detected in 6 of the 7 boreholes, ranging from 1.2 to 4.9 m from the prevailing ground surface, or El. 292.7 to 290.1 m. It will fluctuate with seasons and affected by the tributary of the Humber River located adjacent of the property.

A review of the latest concept plan provided by the City of Richmond Hill indicates that the existing bocce court and the septic system will be removed and replaced with a parking area with covered storage bins for landscape supplies. The existing access driveway and parking area will also be reconfigured to accommodate the increased service vehicle traffic. In addition, there will be a proposed building addition on the east side of the existing building.



The geotechnical findings warranting special consideration for the proposed project are presented below:

1. Prior to construction, the vegetation and topsoil must be removed for site development. The topsoil may be re-used for landscaping in designated areas only. Any surplus should be removed off site.
2. The existing earth fill is not suitable for supporting any structure sensitive to settlement.
3. The proposed addition can be constructed on conventional spread and strip footing founded on the native soil at the same foundation depth of the existing footing or deeper below the frost penetration depth.
4. It is understood that the existing grade within the site will be maintained. Accordingly, it is anticipated that minor maintenance may be required on the proposed pavement structure due to the underlying alluvium and earth fill material revealed by the borehole findings. This can be mitigated with the use of geosynthetic reinforcement grids to distribute the traffic loadings evenly over the subgrade to minimize settlement. The design should be completed by a qualified supplier with experience in this type of conditions.
5. Where the septic system is to be decommissioned, the disturbed area must be inspected to remove any unsuitable material prior to backfilling all cavities with properly compacted inorganic earth fill.
6. Due to the shallow groundwater level encountered within the property and the presence of earth fill throughout the property, further assessment must be carried out for the design of the stormwater management facility within the property.

The recommendations appropriate for the project are presented herein. One must be aware that the subsurface conditions may vary between boreholes. Should any subsurface variance become apparent during construction, a geotechnical engineer must be consulted to determine whether the following recommendations require revision.

6.1 **Site Preparation**

Existing septic system should be removed and properly decommissioned. The cavities can be backfilled with inorganic earth fill compacted to at least 98% Standard Proctor Dry Density (SPDD).

Due to the presence of relatively deep earth fill and alluvium, engineered fill is likely not suitable for the proposed development.



6.2 **Foundation**

Where new structures are to be constructed within the property in the future, foundations must be founded on sound, native soil beneath the pavement structure, topsoil, earth fill and alluvium. Based on the borehole findings, the Maximum Allowable Soil Bearing Pressures (SLS) and Factored Ultimate Soil Bearing Pressures (ULS) for the design of the normal strip and spread footings and their corresponding founding levels are presented in Table 3.

Table 3 - Founding Levels

BH No.	Recommended Maximum Allowable Soil Pressure (SLS)/ Factored Ultimate Soil Bearing Pressure (ULS) and Suitable Founding Level				Inferred Groundwater Level
	60 kPa (SLS)/80 kPa (ULS)		100 kPa (SLS)/160 kPa (ULS)		El. (m)
	Depth (m)	El. (m)	Depth (m)	El. (m)	
1	3.2 or +	291.0 or -	-	-	292.7
2	2.5 or +	291.9 or -	-	-	292.6
3	-	-	4.8 or +	289.1 or -	292.1
4	-	-	4.8 or +	289.7 or -	292.4
5	-	-	2.5 or +	291.8 or -	287.7
6	-	-	2.5 or +	292.1 or -	290.9
7	4.8 or +	289.0 or -	-	-	292.6

Proposed Building Addition (Boreholes 101 and 102)

The proposed building addition located in the vicinity of Boreholes 101 and 102 can be constructed on conventional footings founded on the native soil. The recommended soil bearing pressures for footing design are provided:

- Maximum Soil Bearing Pressure at Serviceability Limit State (SLS) = 150 kPa
- Factored Ultimate Bearing Pressure at Ultimate Limit State (ULS) = 250 kPa

The total and differential settlements of structures designing for the bearing pressure at SLS are estimated within 25 mm and 20 mm, respectively.

The foundation subgrade should be inspected by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that the revealed conditions are compatible with the foundation design requirements.



At the boundary of the new addition with the existing structure, the new footings should be founded at the same elevation with the existing footings, or below the frost depth, whichever is deeper. Where the new footings are deeper than the existing foundations, the existing footings should be properly stepped and underpinned.

Where stepped footings are required, a gradient of 10 horizontal:7 vertical must be maintained.

The existing footings or foundation configuration should be investigated for the proposed building addition. Construction joints or slip-joints should be provided at the interface of the new structure and the existing building. This is to allow for differential movement at the interface, without imposing structural distress on the existing structure.

Footings exposed to weathering or in unheated areas should have at least 1.2 m of earth cover for protection against frost action.

It should be noted that if groundwater seepage is encountered in the footing area, the footing subgrade should be protected by a concrete mud-slab immediately after exposure. This will prevent construction disturbance and costly rectification.

The building foundations should meet the requirements specified in the latest Ontario Building Code and the structures should be designed to resist an earthquake force using Site Classification 'D' (stiff soil).

Deeper boreholes will be necessary if higher bearing capacity is required. Soil improvement techniques or helical piers can be considered once the competent ground surface has been identified through additional investigation.

6.3 **Slab-On-Grade Construction**

The subgrade for slab-on-grade structures, such as concrete slabs for storage bins, must consist of sound native soils or properly compacted inorganic earth fill. In preparation of the subgrade, the subgrade should be inspected and assessed by proof-rolling. Any weathered and/or loose/unsuitable soil should be subexcavated, sorted free of any deleterious material, aerated and uniformly compacted to at least 98% Standard Proctor Dry Density (SPDD).

The concrete slab must be constructed on a 20 mm thick granular bedding, consisting of 19-mm Crusher-Run Limestone, compacted to 100% SPDD.



For a minimum bedding thickness of 20 cm, a Modulus of Subgrade Reaction (k_s) of 25 MPa/m can be used for slab design. The k_s value can be increased slightly with the increase of thickness in the granular bedding.

In areas where ground movement cannot be tolerated, the slab can be constructed on a free-draining granular base of 0.3 to 1.2 m thick, depending on the degree of tolerance for settlement. These measures, with proper drainage at the bottom, will minimize the movement by preventing the accumulation of water in the granular base.

The grading around the slab must be such that it directs runoff away from the structure.

6.4 **Underground Services**

The underground services should be founded on sound native soil or properly compacted inorganic earth fill. Where incompetent or weathered soil is encountered, it should be subexcavated and replaced with the bedding material, compacted to at least 98% SPDD.

A Class 'B' bedding, consisting of 19-mm Crusher-Run Limestone, or equivalent, is recommended for the underground service construction. A Class 'A' concrete bedding is recommended where saturated sand is found in the subgrade or for areas where extensive dewatering is required.

The pipe joints connecting into the manholes and catch basins must be leak-proof to prevent the migration of fines through the joints. Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting.

A soil cover of at least the diameter of the pipe should be in place at all times after pipe installation to prevent pipe floatation when the trench is deluged with water derived from precipitation.

The on-site soil is corrosive to ductile iron pipes and metal fittings; therefore, they should be protected against soil corrosion. For estimation for the anode weight requirements, the electrical resistivities of the disclosed soils can be used. The proposed anode weight must meet the minimum requirements as specified by the municipality standard.

6.5 **Backfilling in Trenches and Excavated Areas**

Most of the on-site inorganic soils, where it is free of concentrated topsoil and deleterious materials, are suitable for trench backfill; however, alluvium should not be reused for structural backfill since it contains organics which is hard to remove and is too wet to



compact. The backfill material should be sorted free of boulders or oversized rock pieces (over 15 cm in size).

The backfill in service trenches should be compacted to at least 98% SPDD, particularly in the zone within 1.0 m below the pavement. The material should be compacted with the water content at 2% to 3% drier than the optimum. The lift of each backfill layer should either be limited to a thickness of 20 cm, or the thickness should be determined by test strips.

In normal sewer construction practice, the problem areas of ground settlement largely occur adjacent to manholes, catch basins and services crossings, foundation walls and columns. In areas which are inaccessible to a heavy compactor, sand backfill should be used and compacted with lighter equipment.

The narrow trenches should be cut at 1 vertical:2 or + horizontal so that the backfill can be effectively compacted. Otherwise, soil arching will prevent the achievement of proper compaction.

6.6 **Pavement Design**

The recommended pavement design for on grade parking and access roadway is presented in Table 4.

Table 4 - Pavement Design

Course	Thickness (mm)	OPS Specifications
Asphalt Surface Course	40	HL3
Asphalt Base Course Light-Duty Parking Heavy-Duty/Fire Route	50 60	HL8
Granular Base	150	Granular 'A' or equivalent
Granular Sub-base Light-Duty Parking Heavy-Duty Parking	300 450	Granular 'B' or equivalent

In preparation of pavement subgrade, any topsoil and compressible material should be removed. The final subgrade must be proof-rolled and inspected. Any soft spot identified must be rectified by subexcavation and replacing with selected dry inorganic material. The subgrade within 1.0 m below the underside of the granular sub-base must be compacted to at least 98% SPDD, with the water content at 2% to 3% drier than its optimum.



All the granular bases should be compacted to 100% SPDD.

If the pavement is to be constructed during the wet seasons and extensively soft subgrade occurs, the granular sub-base may require thickening. This can be assessed during construction.

With the presence of alluvium, the pavement subgrade will be subject to long term settlement. It is recommended that a geosynthetic reinforcement grid should be provided between the subgrade and the granular sub-base to allow uniform settlement and reinforcement in the pavement. A specialist should be consulted to determine the type of reinforcement product to use for this application. The extent of the area requiring the reinforcement is identified in Drawing No. 1. Fiber reinforced asphalt can also be considered to prolong the service life of the pavement.

Along the perimeter where surface runoff may drain onto the pavement, the areas should be properly graded to direct the runoff away. Subdrains consisting of filter-wrapped weepers, should be provided along the perimeter and at low spots and be connected to the catch basins or storm manholes in the paved areas. The invert of the subdrains should be at least 0.4 m beneath the underside of the granular sub-base and backfilled with free-draining granular material.

6.7 Soil Parameters

The recommended soil parameters for the project design are given in Table 5.

Table 5 - Soil Parameters

<u>Unit Weight and Bulk Factor</u>	<u>Unit Weight</u> <u>γ (kN/m³)</u>		<u>Estimated</u> <u>Bulk Factor</u>	
	<u>Bulk</u>	<u>Submerged</u>	<u>Loose</u>	<u>Compacted</u>
Sandy Silt Till	22.5	12.5	1.25	1.05
Existing Fill, Sand and Silt	20.5 to 21.0	11.0	1.25	1.00
<u>Lateral Earth Pressure Coefficients</u>	<u>Active</u> <u>K_a</u>	<u>At Rest</u> <u>K₀</u>	<u>Passive</u> <u>K_p</u>	
Compacted Earth Fill	0.40	0.55	2.55	
Sandy Silt Till and Silt	0.35	0.52	2.88	
Sand	0.33	0.50	3.00	

**Table 5 - Soil Parameters (Cont'd)**

<u>Coefficients of Friction</u>	
Between Concrete and Granular Soil	0.50
Between Concrete and Sound Native Soils	0.35

6.8 **Excavation**

Excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified in Table 6.

Table 6 - Classification of Soils for Excavation

Material	Type
Earth Fill, Sandy Silt Till and Drained Sand and Silt	3
Alluvium, Saturated Sand and Silt	4

In excavation, the groundwater yield will be appreciable and persistent. Any excavation will have to be controlled by a dewatering system. Vigorous pumping from closely spaced sumps, or if required, the use of well-point dewatering system may be required to control any groundwater seepages encountered during excavation.



7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of the City of Richmond Hill, and for review by the designated consultants and government agencies. The material in the report reflects the judgment of Yinglin Xiao, EIT, Kelvin Hung, P.Eng., and Bernard Lee, P.Eng. in light of the information available to it at the time of preparation. Use of the report is subject to the conditions and limitations of the contractual agreement. Any use which a Third Party makes of this report, and/or any reliance on decisions to be made based on it are the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

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LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS Auger sample
CS Chunk sample
DO Drive open (split spoon)
DS Denison type sample
FS Foil sample
RC Rock core (with size and percentage recovery)
ST Slotted tube
TO Thin-walled, open
TP Thin-walled, piston
WS Wash sample

SOIL DESCRIPTION

Cohesionless Soils:

<u>'N' (blows/ft)</u>	<u>Relative Density</u>
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—●—'

Undrained Shear
Strength (ksf)

less than 0.25
0.25 to 0.50
0.50 to 1.0
1.0 to 2.0
2.0 to 4.0
over 4.0

'N' (blows/ft)

0 to 2	very soft
2 to 4	soft
4 to 8	firm
8 to 16	stiff
16 to 32	very stiff
over 32	hard

Consistency

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding

△ Laboratory vane test

□ Compression test in laboratory

WH Sampler advanced by static weight
PH Sampler advanced by hydraulic pressure
PM Sampler advanced by manual pressure
NP No penetration

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres
1lb = 0.454 kg

1 inch = 25.4 mm
1ksf = 47.88 kPa



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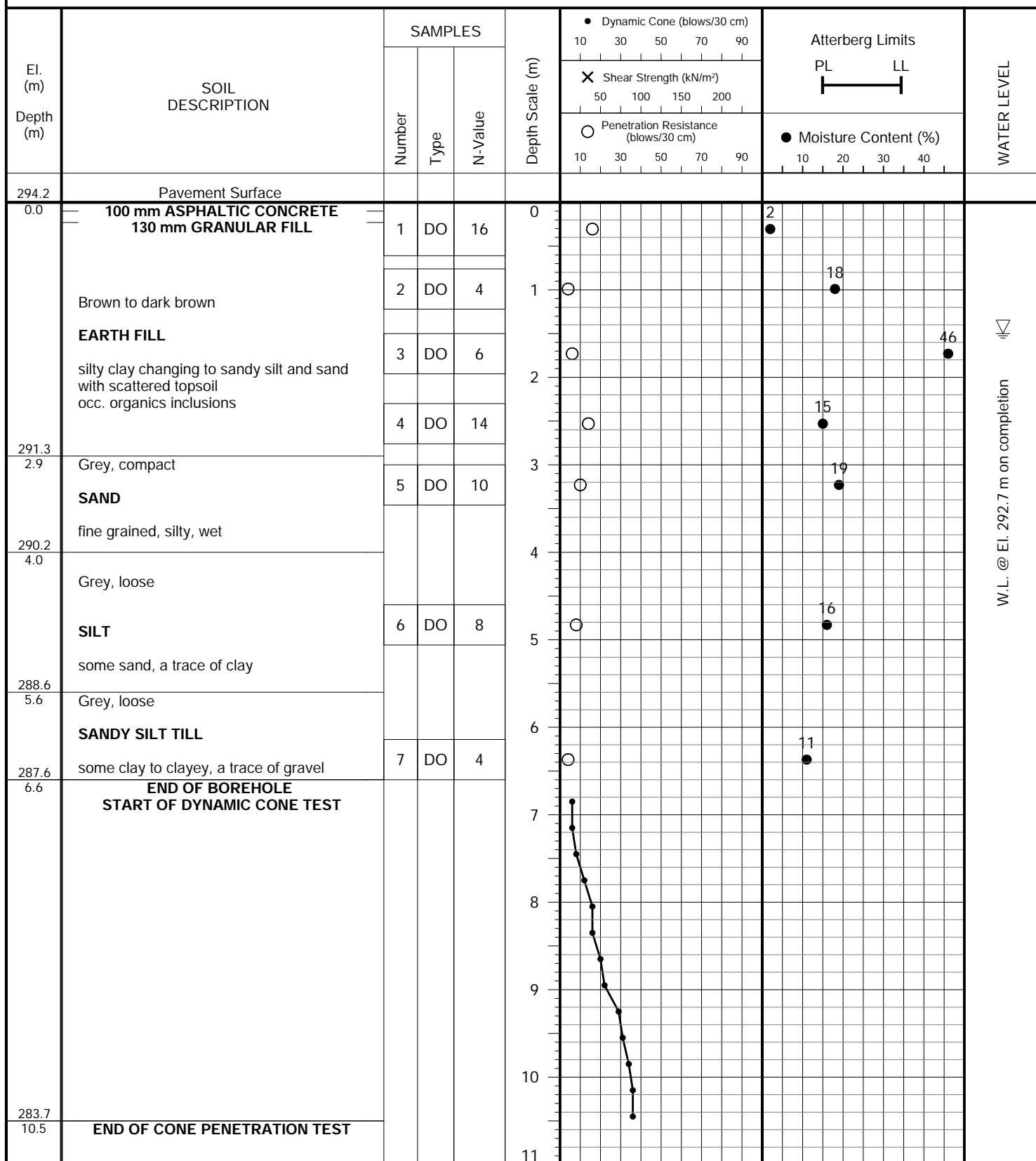
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JOB NO.: 2207-S017

LOG OF BOREHOLE: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: 39 King Road, City of Richmond Hill**METHOD OF BORING:** Solid-Stem Auger**PROJECT LOCATION:** Proposed Building Redevelopment**DRILLING DATE:** July 21, 2022**Soil Engineers Ltd.**

JOB NO.: 2207-S017

LOG OF BOREHOLE:

101

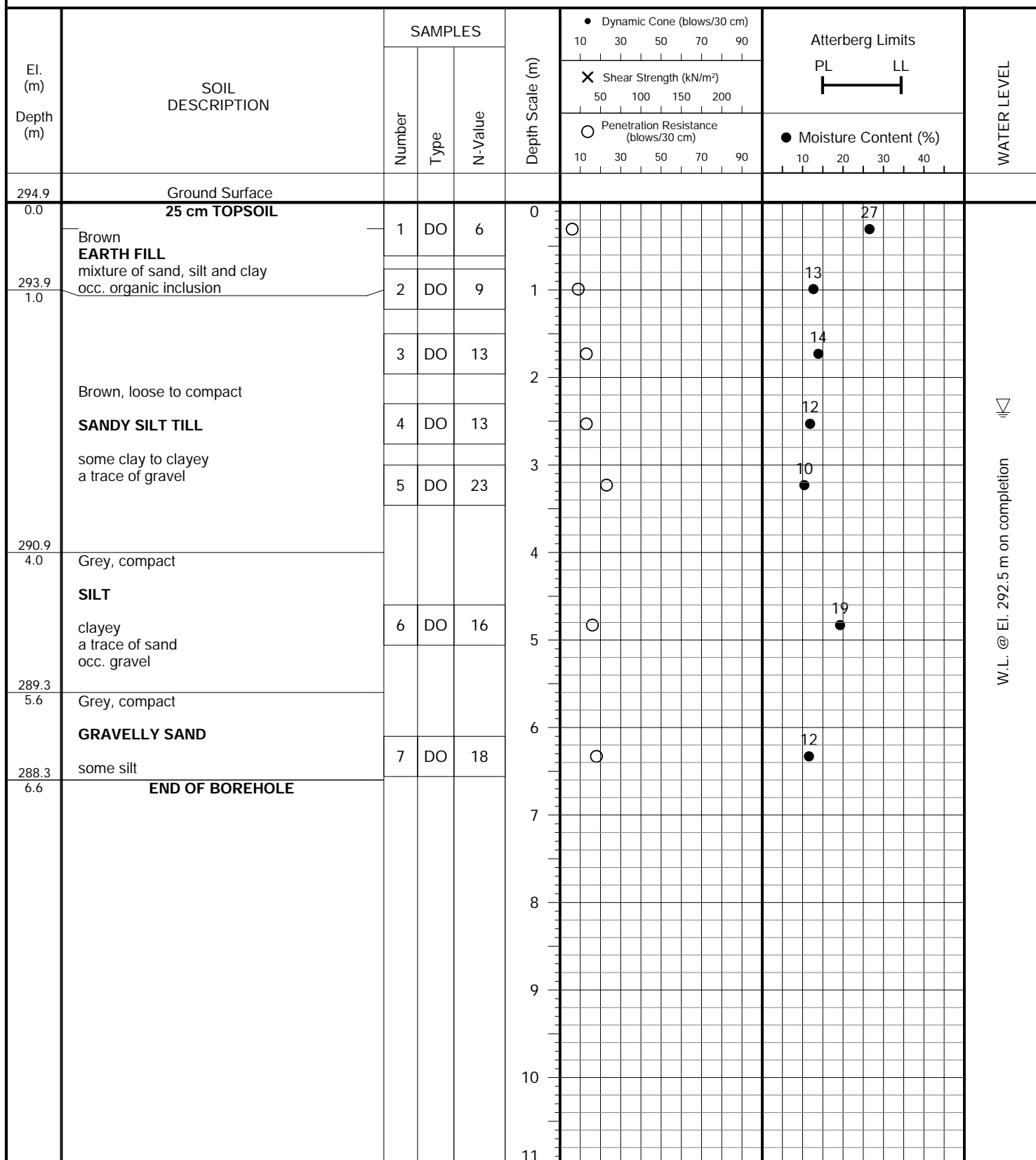
FIGURE NO.: 8

PROJECT DESCRIPTION: 39 King Road, City of Richmond Hill

METHOD OF BORING: Solid-Stem Auger

PROJECT LOCATION: Proposed Building Redevelopment

DRILLING DATE: April 25, 2023



Soil Engineers Ltd.

JOB NO.: 2207-S017

LOG OF BOREHOLE:

102

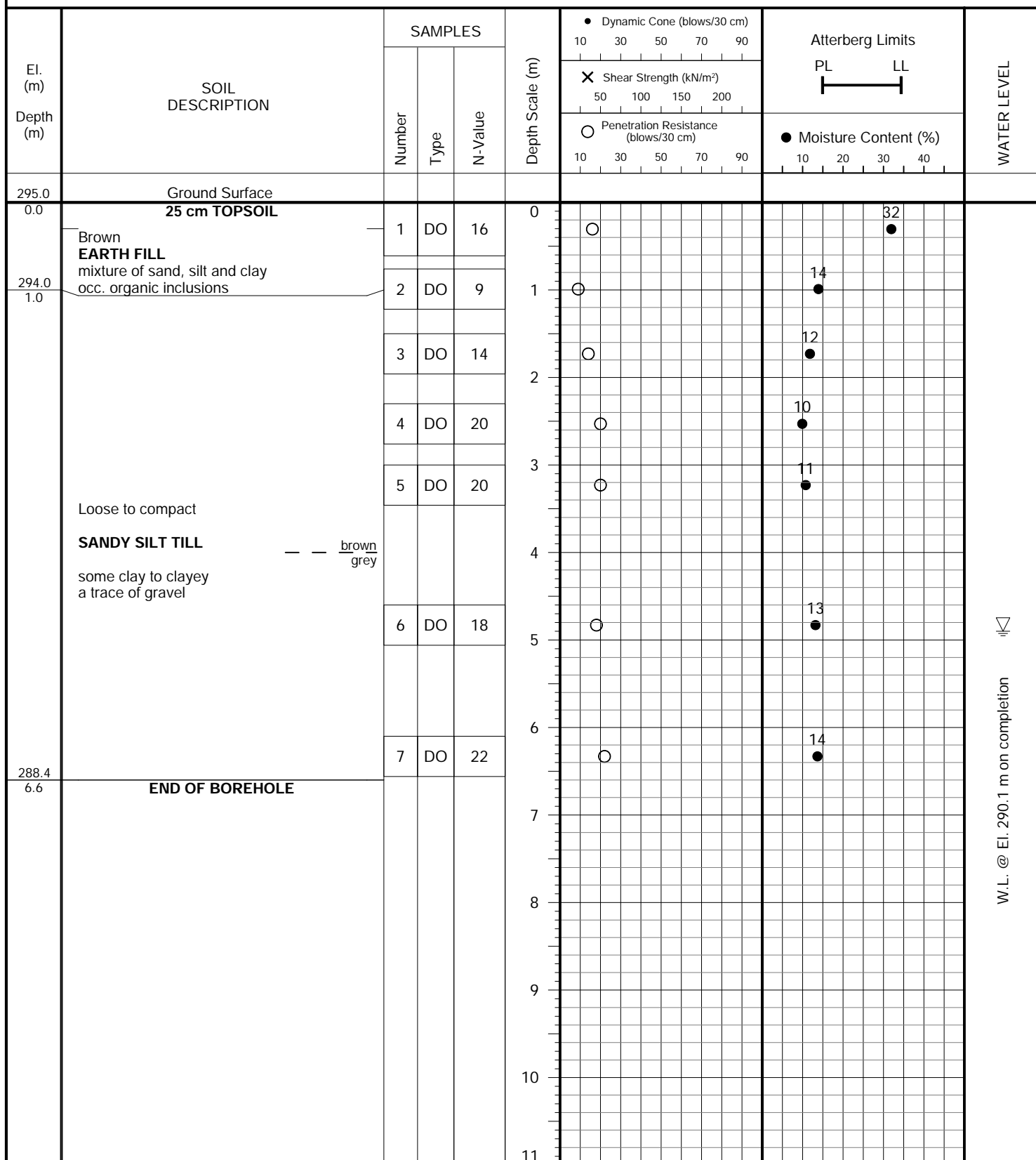
FIGURE NO.: 9

PROJECT DESCRIPTION: 39 King Road, City of Richmond Hill

METHOD OF BORING: Solid-Stem Auger

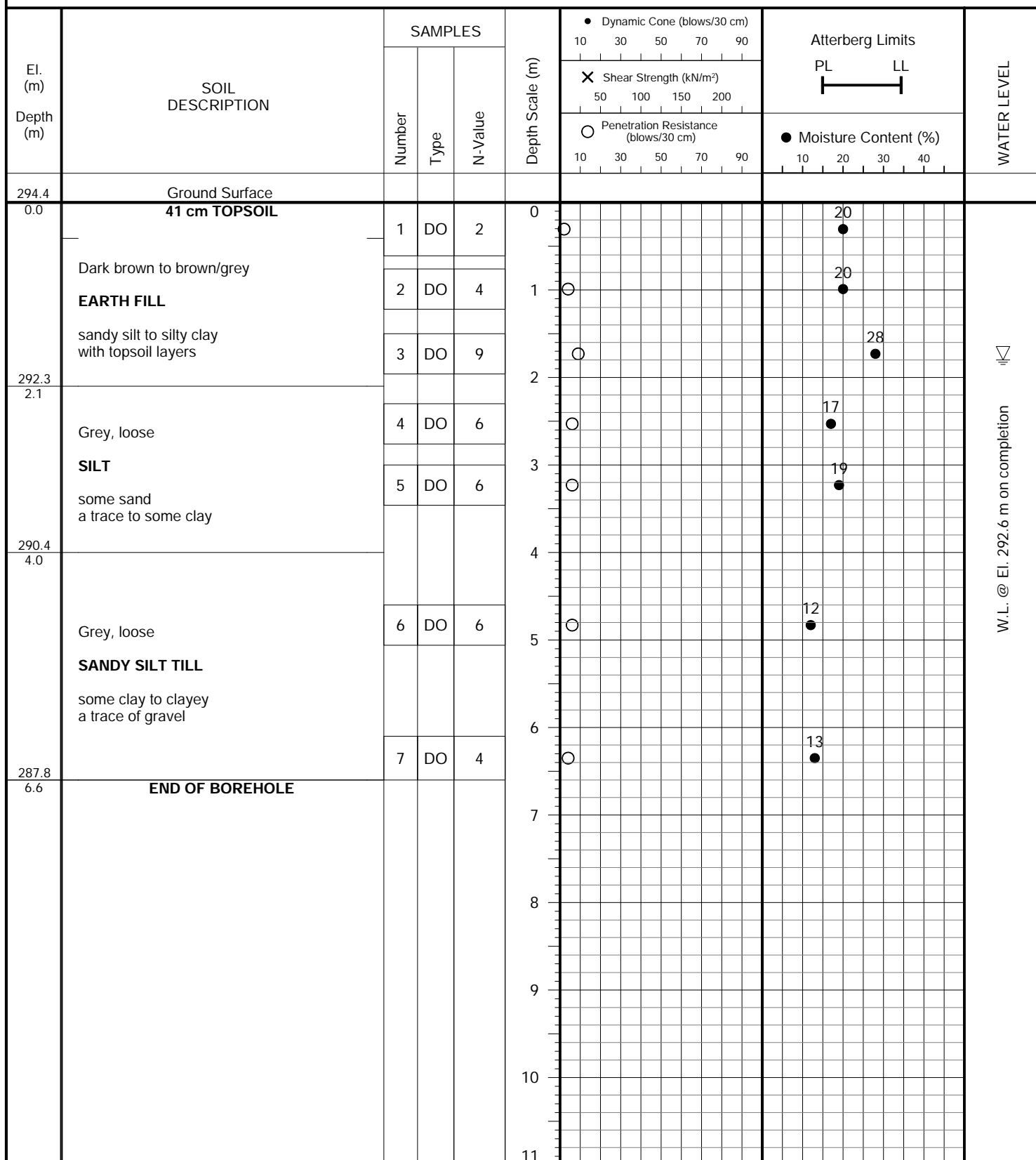
PROJECT LOCATION: Proposed Building Redevelopment

DRILLING DATE: April 25, 2023



Soil Engineers Ltd.

JOB NO.: 2207-S017

LOG OF BOREHOLE:**2****FIGURE NO.: 2****PROJECT DESCRIPTION:** 39 King Road, City of Richmond Hill**METHOD OF BORING:** Solid-Stem Auger**PROJECT LOCATION:** Proposed Building Redevelopment**DRILLING DATE:** July 21, 2022**Soil Engineers Ltd.**

JOB NO.: 2207-S017

LOG OF BOREHOLE:

3

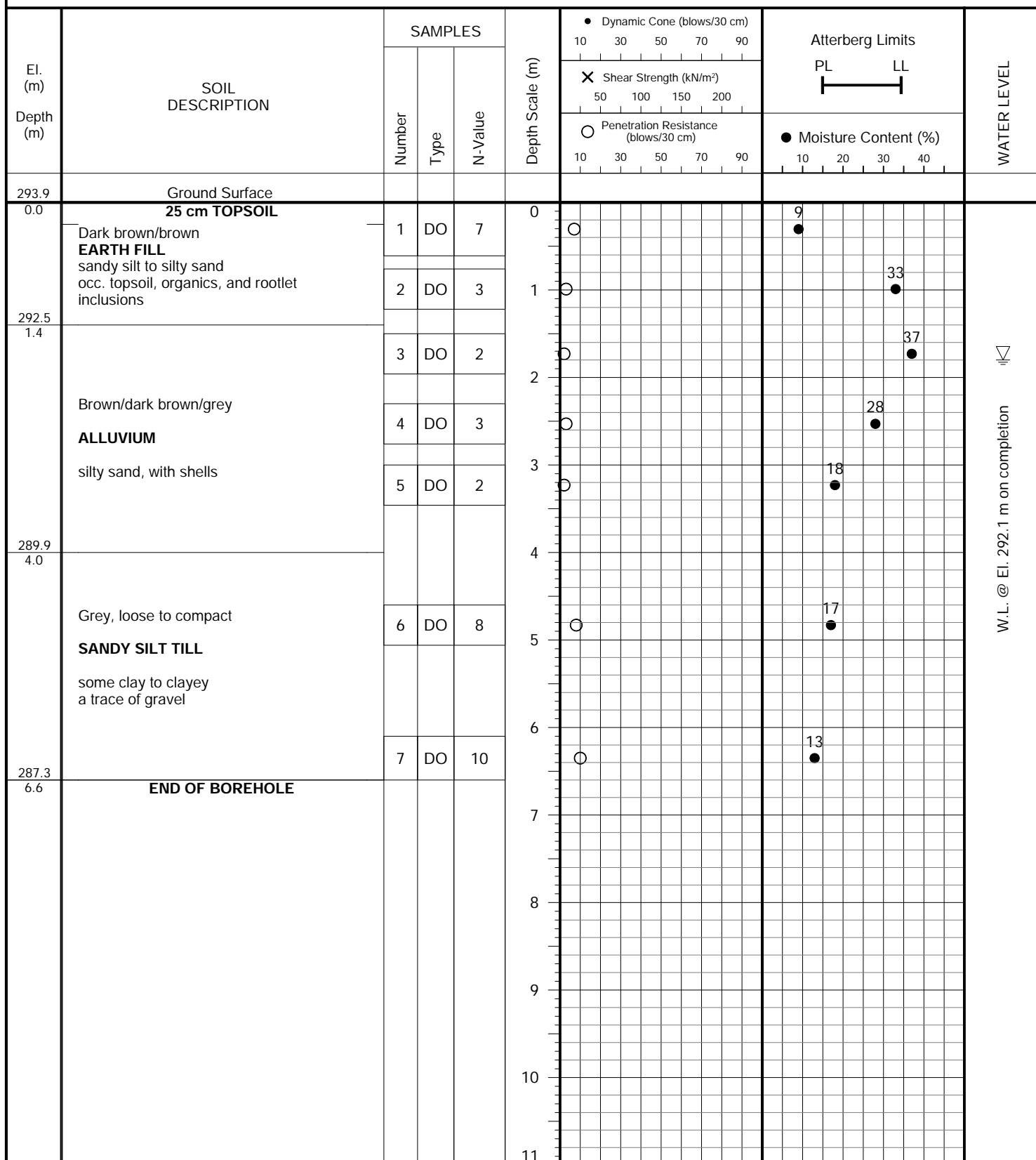
FIGURE NO.: 3

PROJECT DESCRIPTION: 39 King Road, City of Richmond Hill

METHOD OF BORING: Solid-Stem Auger

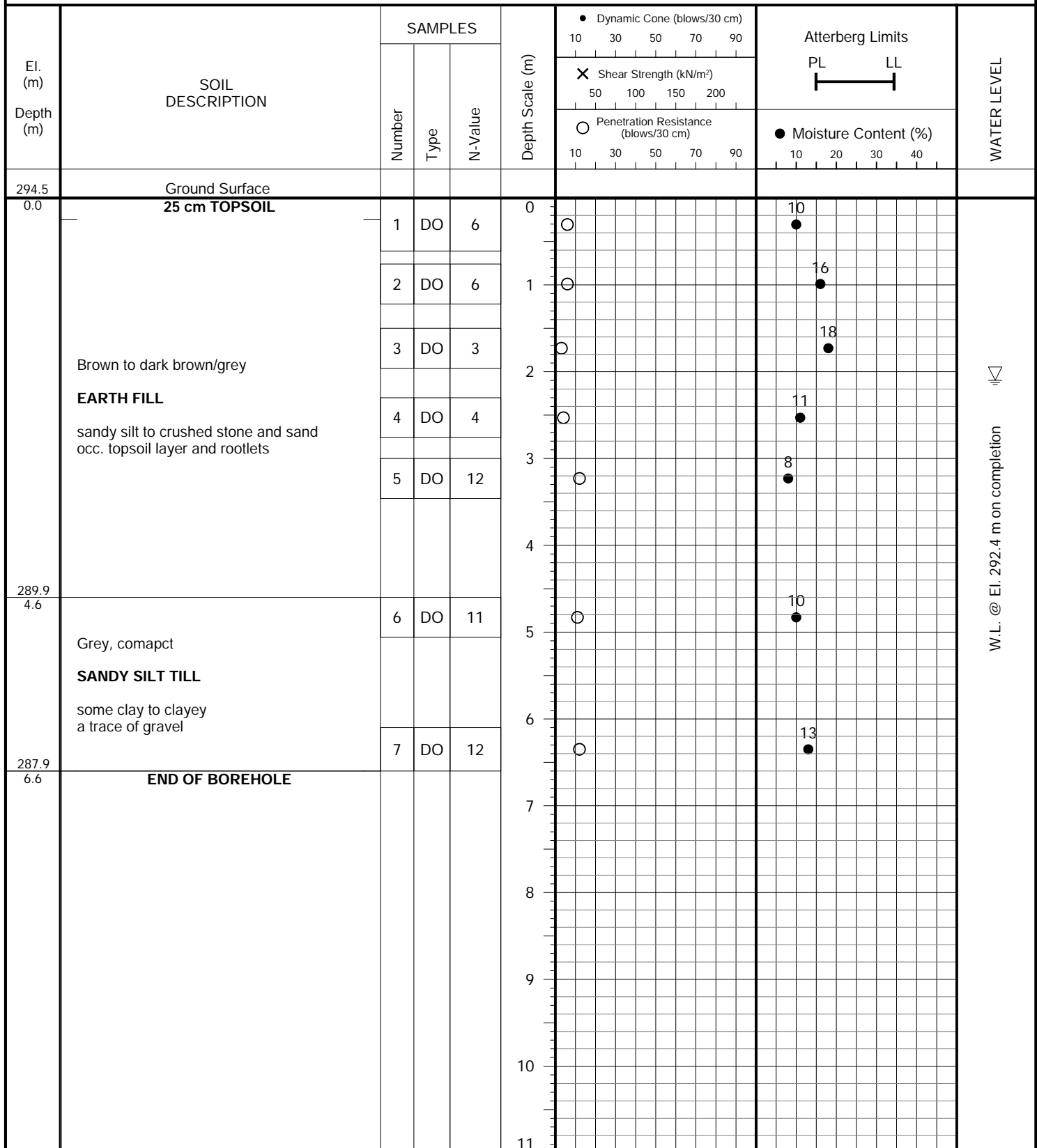
PROJECT LOCATION: Proposed Building Redevelopment

DRILLING DATE: July 21, 2022



Soil Engineers Ltd.

JOB NO.: 2207-S017

LOG OF BOREHOLE:**4****FIGURE NO.: 4****PROJECT DESCRIPTION:** 39 King Road, City of Richmond Hill**METHOD OF BORING:** Solid-Stem Auger**PROJECT LOCATION:** Proposed Building Redevelopment**DRILLING DATE:** July 21, 2022**Soil Engineers Ltd.**

JOB NO.: 2207-S017

LOG OF BOREHOLE:

5

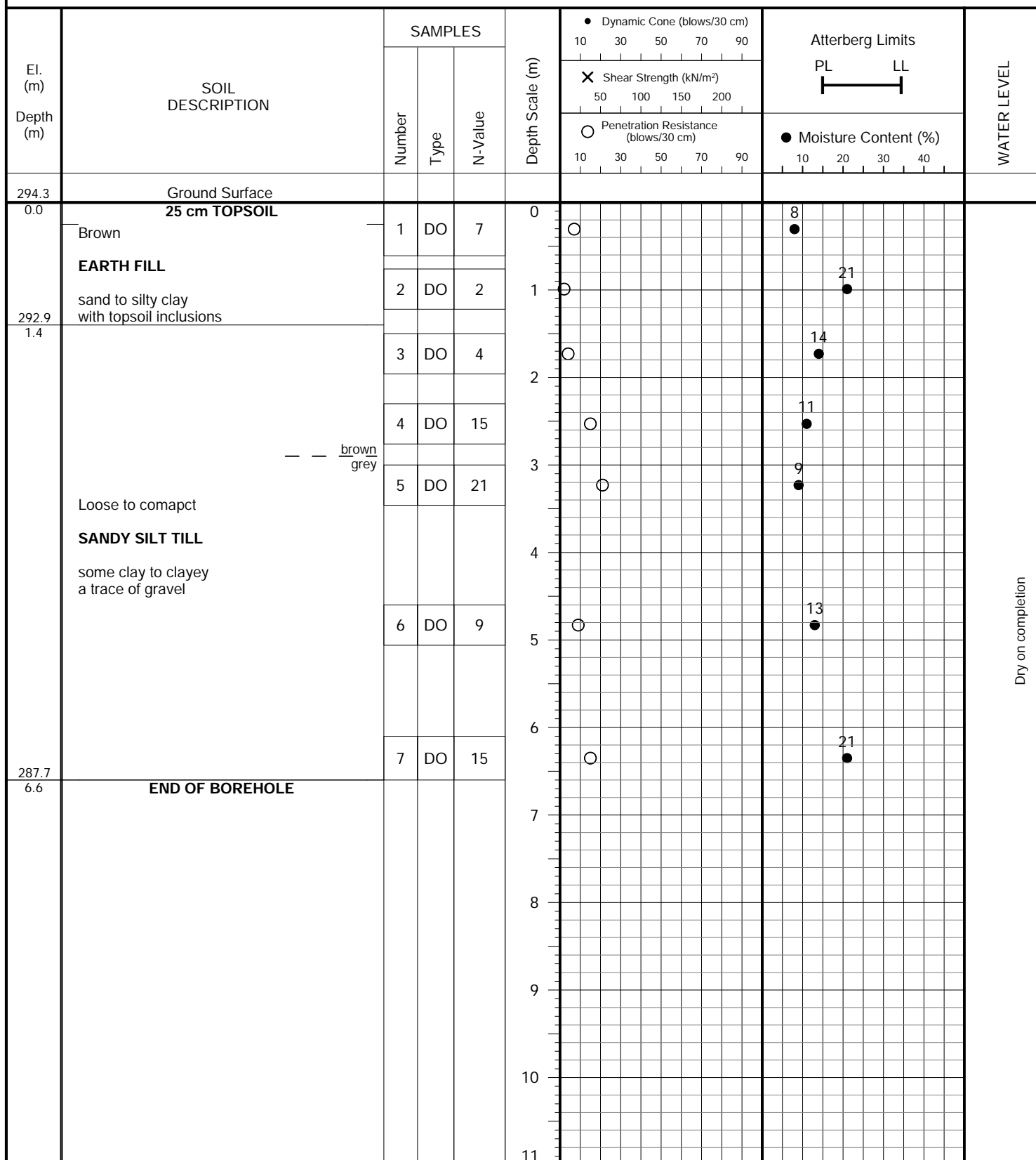
FIGURE NO.: 5

PROJECT DESCRIPTION: 39 King Road, City of Richmond Hill

METHOD OF BORING: Solid-Stem Auger

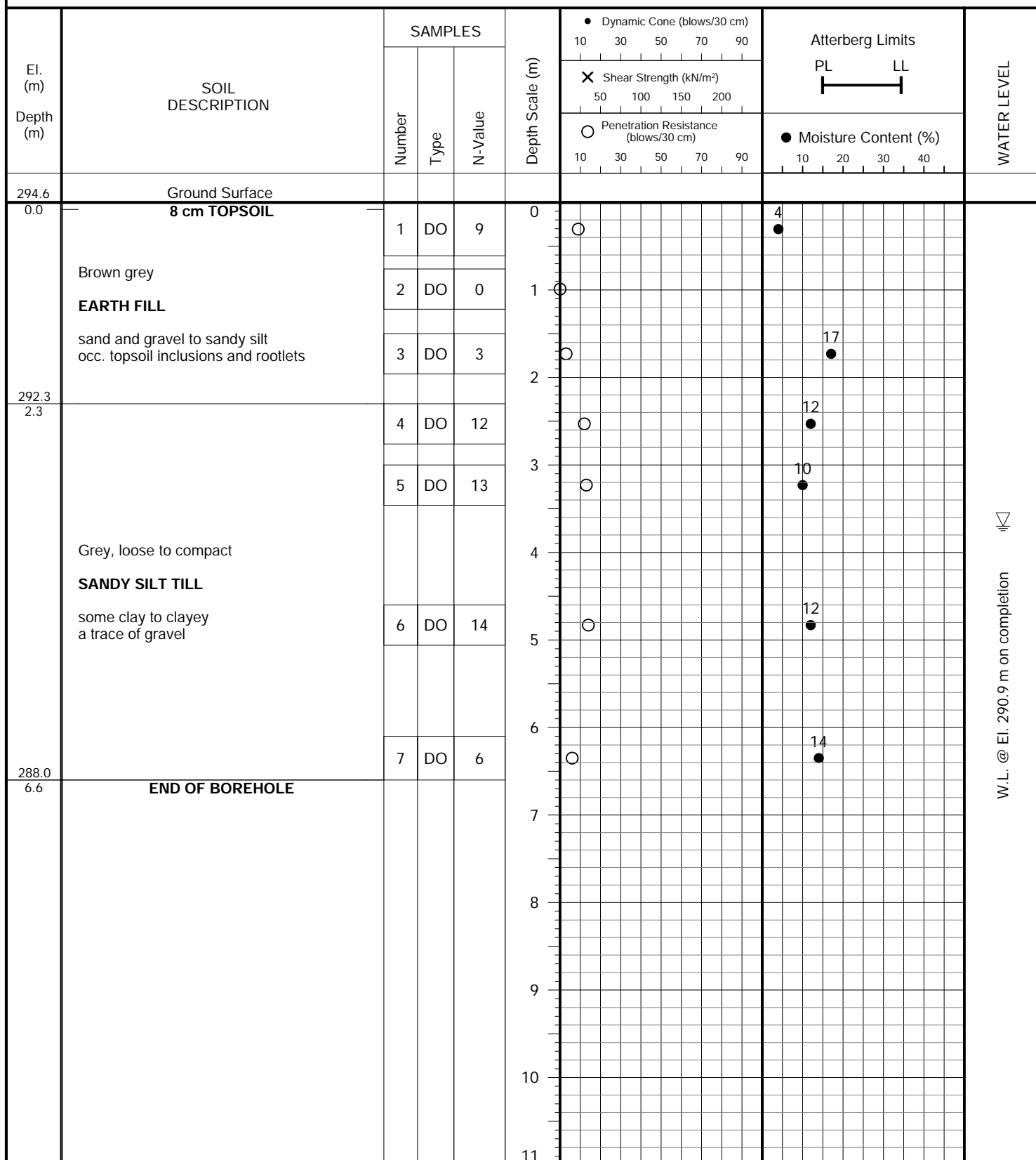
PROJECT LOCATION: Proposed Building Redevelopment

DRILLING DATE: July 21, 2022



Soil Engineers Ltd.

JOB NO.: 2207-S017

LOG OF BOREHOLE:**6****FIGURE NO.: 6****PROJECT DESCRIPTION:** 39 King Road, City of Richmond Hill**METHOD OF BORING:** Solid-Stem Auger**PROJECT LOCATION:** Proposed Building Redevelopment**DRILLING DATE:** July 21, 2022**Soil Engineers Ltd.**

JOB NO.: 2207-S017

LOG OF BOREHOLE:

7

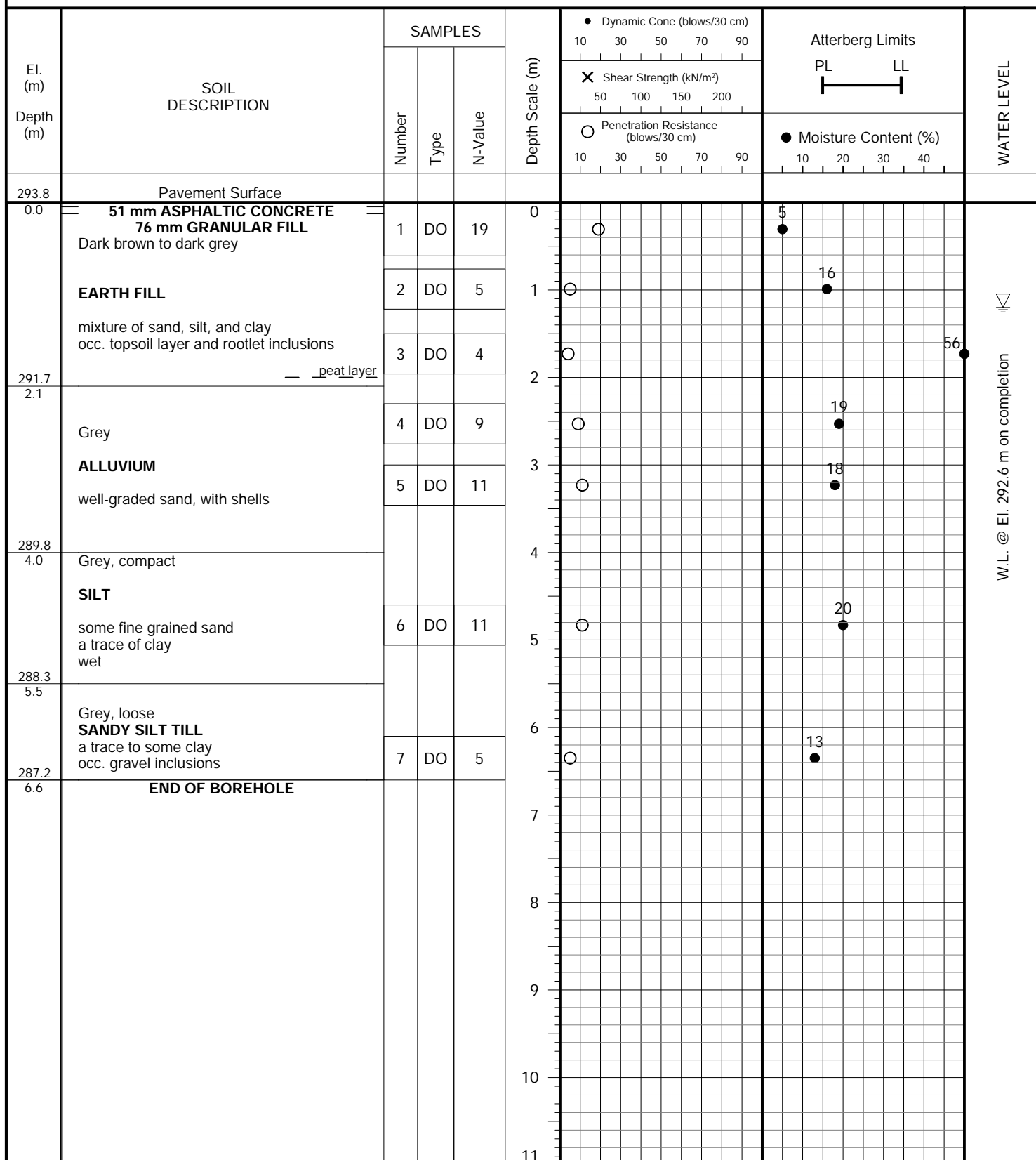
FIGURE NO.: 7

PROJECT DESCRIPTION: 39 King Road, City of Richmond Hill

METHOD OF BORING: Solid-Stem Auger

PROJECT LOCATION: Proposed Building Redevelopment

DRILLING DATE: July 21, 2022



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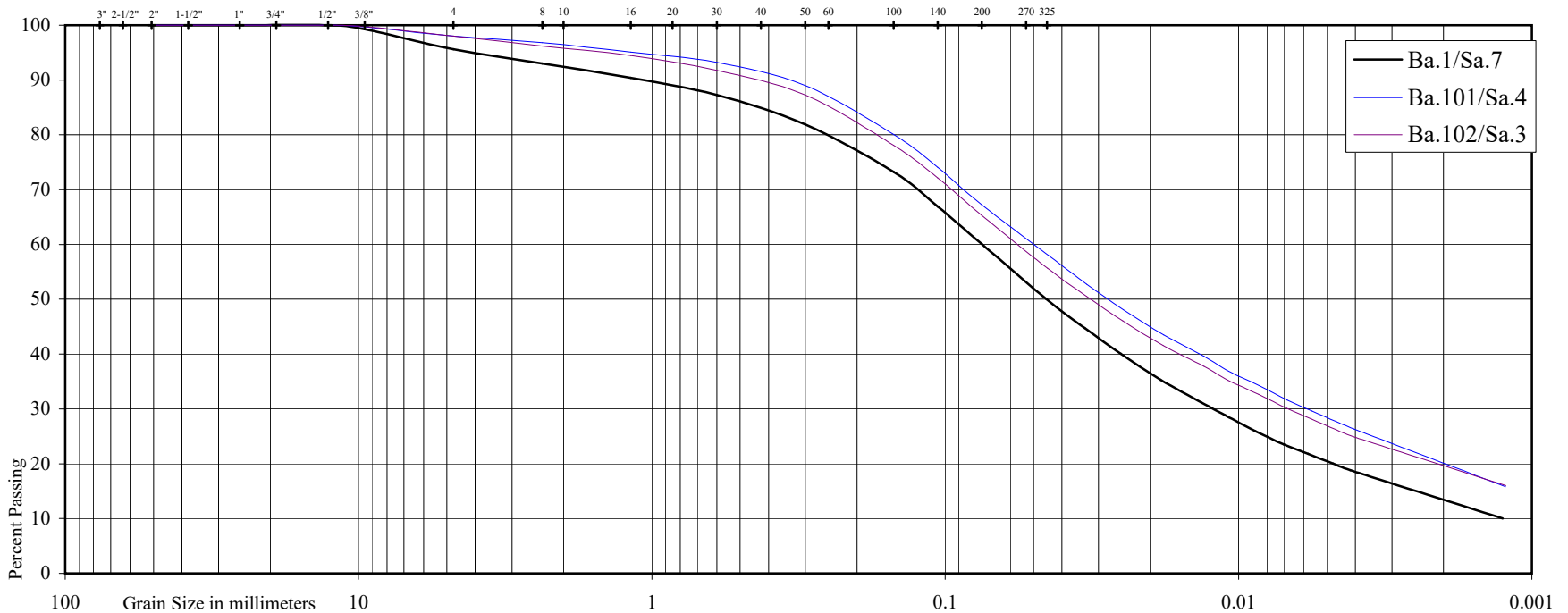


U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL		SAND				SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Building Redevelopment
Location: 39 King Road, City of Richmond Hill

Borehole No:	1	101	102
Sample No:	7	4	3
Depth (m):	6.3	2.5	1.8
Elevation (m):	287.9	292.4	293.2

BH./Sa.	1/7	101/4	102/3
Liquid Limit (%) =	-	-	-
Plastic Limit (%) =	-	-	-
Plasticity Index (%) =	-	-	-
Moisture Content (%) =	11	12	12
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}

Classification of Sample [& Group Symbol]: SANDY SILT, TILL
some clay, a trace of gravel

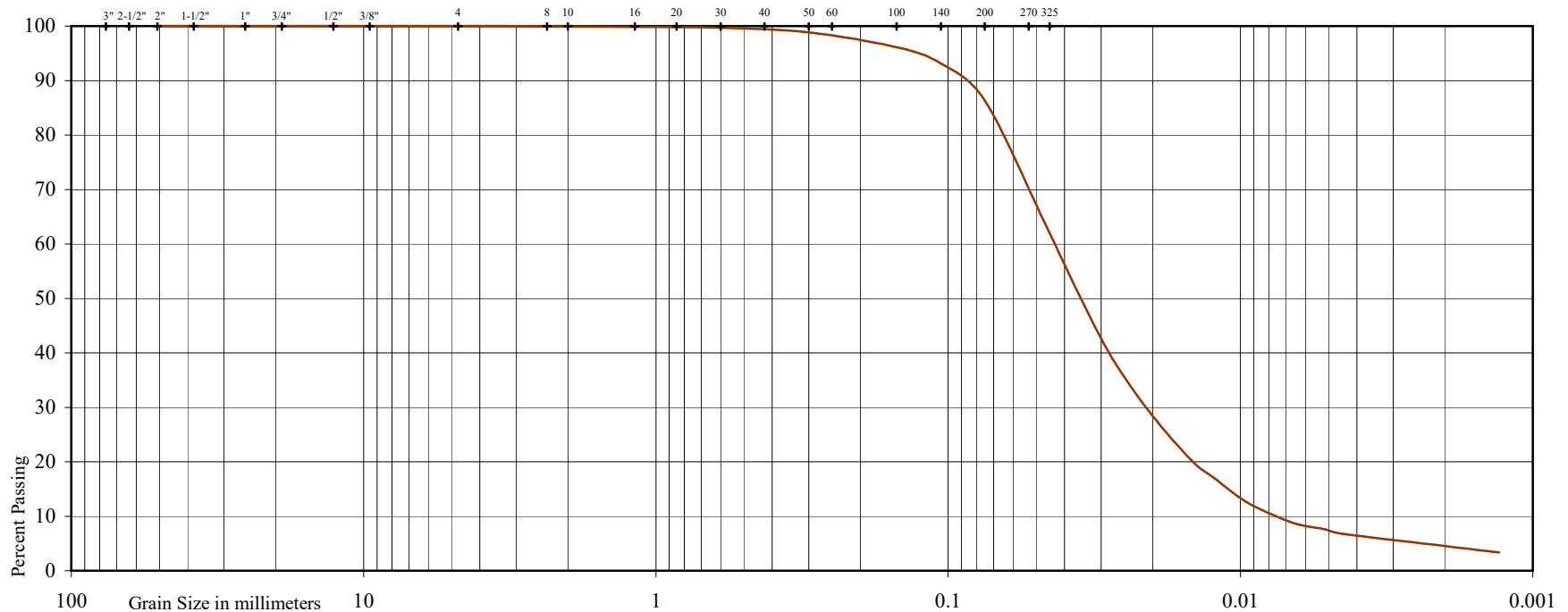


U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL			SAND				SILT	CLAY
COARSE		FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



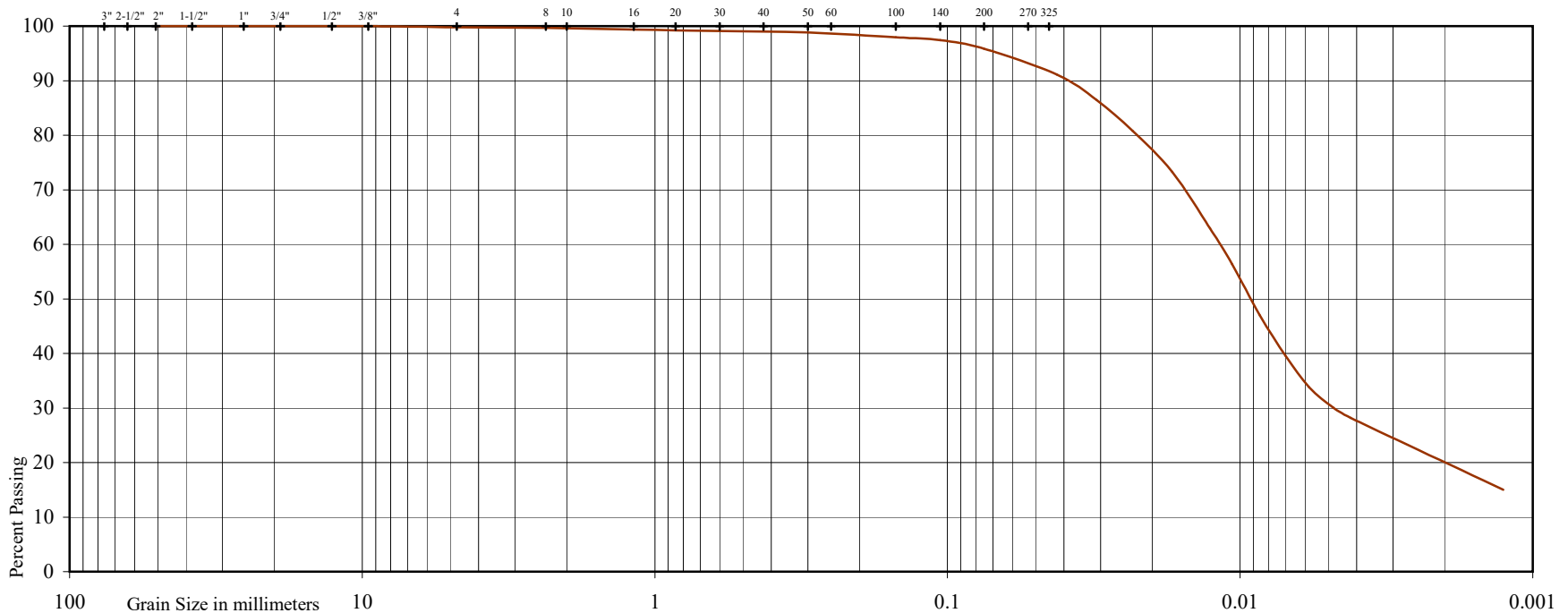


U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL			SAND				SILT	CLAY
COARSE		FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



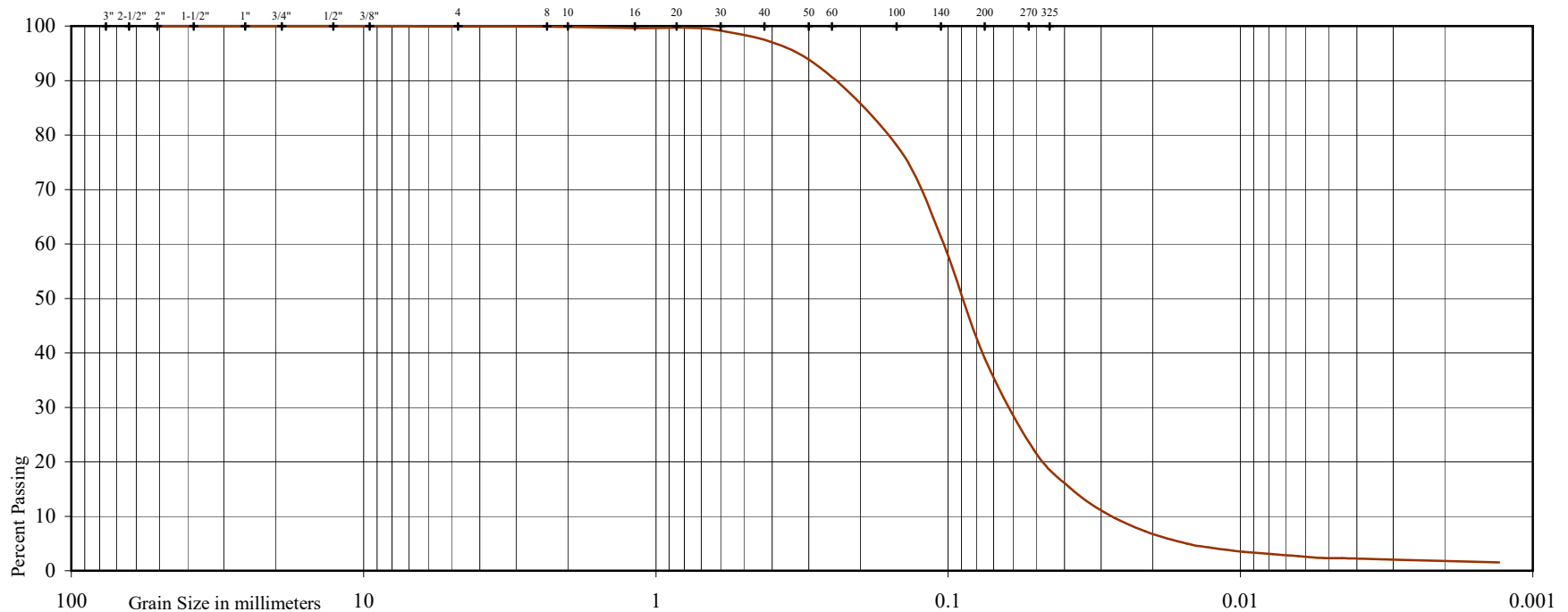


U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL			SAND				SILT	CLAY
COARSE		FINE	COARSE	MEDIUM	FINE	V. FINE		

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



Project: Proposed Building Redevelopment
Location: 39 King Road, City of Richmond Hill

Borehole No: 1
Sample No: 5
Depth (m): 3.2
Elevation (m): 291.0

Liquid Limit (%) = -
Plastic Limit (%) = -
Plasticity Index (%) = -
Moisture Content (%) = 19
Estimated Permeability (cm./sec.) = 10^{-3}

Classification of Sample [& Group Symbol]: SAND
fine grained, silty



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SUBSURFACE PROFILE

DRAWING NO. 2

SCALE: AS SHOWN

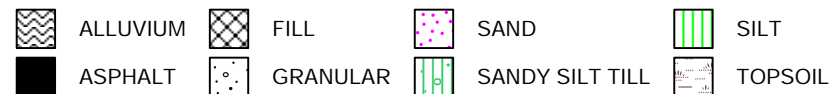
JOB NO.: 2207-S017

REPORT DATE: May 2023

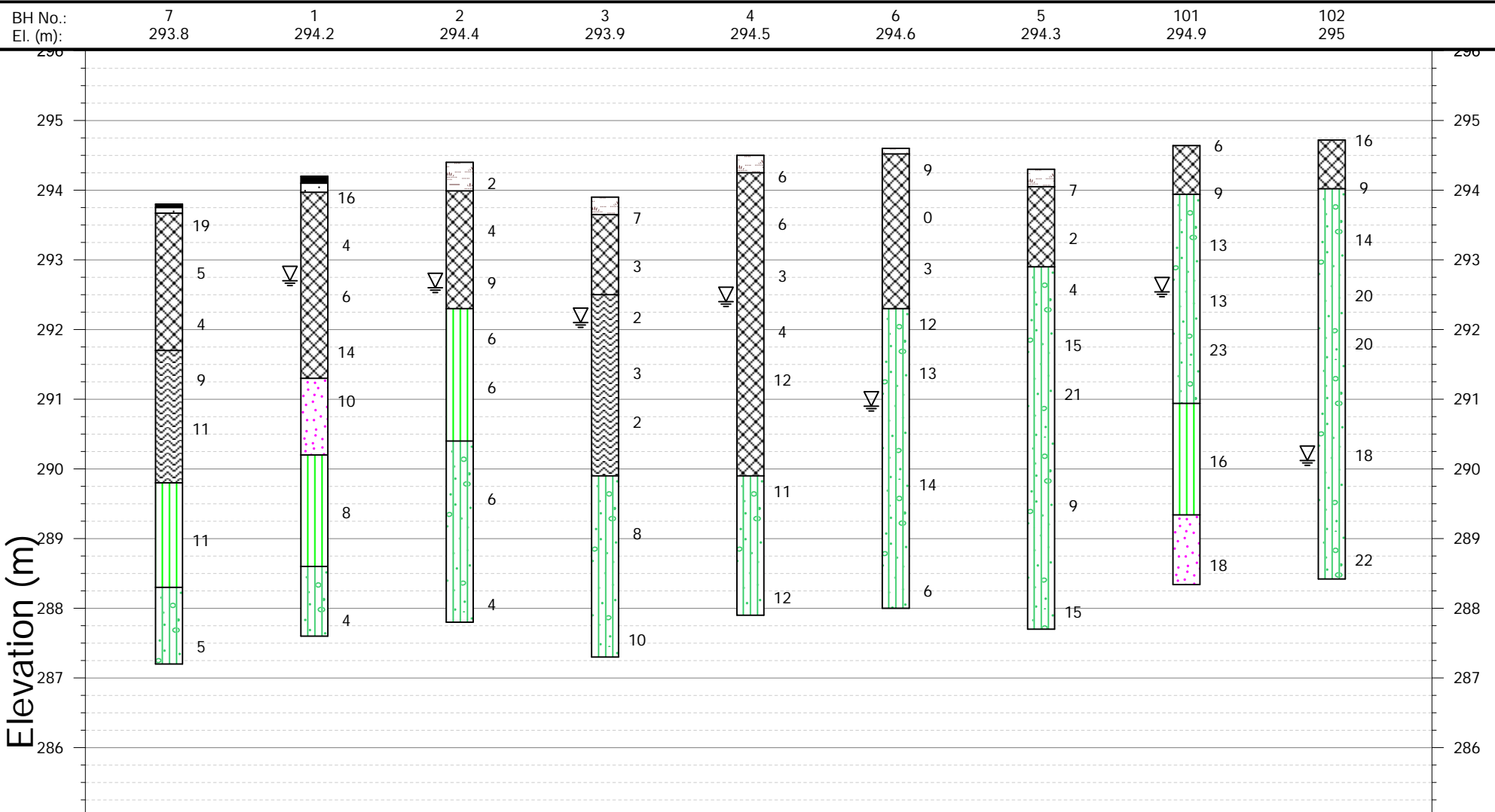
PROJECT DESCRIPTION: 39 King Road, City of Richmond Hill

PROJECT LOCATION: Proposed Building Redevelopment

LEGEND



▽ WATER LEVEL (END OF DRILLING)



APPENDIX

G2 GEOTECHNICAL REPORT



Soil Characterization Report
Soil Engineers Ltd.
March 17, 2025



Soil Engineers Ltd.

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FAX: (905) 725-1315

HAMILTON
TEL: (905) 777-7956
FAX: (905) 542-2769

April 14, 2025

(Revision to report dated March 17, 2025)

Reference No. 2501-E028

Page 1 of 7

City of Richmond Hill
225 East Beaver Creek Road
Richmond Hill, Ontario
L4B 3P4

Attention: Mr. Andrew Beshay, P.Eng., PMP

**Re: Soil Characterization Report
Proposed Building Redevelopment
39 King Road
City of Richmond Hill**

Dear Sir:

Soil Engineers Ltd. (SEL) was retained by City of Richmond Hill to conduct an environmental soil sampling and chemical testing and prepare a Soil Characterization Report (SCR) for excess soil at the captioned project. SEL understands that a SCR is required for excess soil management planning purposes prior to the export of excess soil that will be generated during the proposed retrofit project. This SCR was carried out in accordance with the requirements of "Rules for Soil Management and Excess Soil Quality Standards", per O. Reg. 406/19 ("On-Site and Excess Soil Management"), made under the EPA, R.S.O. 1990, c. E. 19.

Background Information

In August 2024, Englobe Corp. (Englobe) was retained by NAC Constructors Ltd. to conduct an environmental soil sampling and testing program for soils excavated from trenching-related activities at the subject site. The trench was opened along the access to the adjacent property. The objective of the soil sampling and testing program was to determine the environmental quality of the soil to be excavated and evaluate potential re-use and/or disposal options, based on the results of testing. Three (3) soil samples were collected and submitted for analysis of Metals and Inorganics (M&I), Petroleum Hydrocarbons (PAHs), Volatile Organic Compounds (VOCs), Polychlorinated Biphenyls (PCBs), and Polycyclic Aromatic Hydrocarbons (PAHs) parameters. Results were compared to Table 1 RPIICC, Table 2.1 RPI and ICC, and Table 3.1 RPI and ICC from the Ontario Regulation (O.Reg.) 406/19 Excess Soil Quality Standards.

This letter/report/certification was prepared by Soil Engineers Ltd. for the account of the captioned clients and may be relied upon by regulatory agencies. The material in it reflects the writer's best judgement in light of the information available to it at the time of preparation. Any use which a third party makes of this letter/report/certification, or any reliance on or decisions to be made based upon it, are the responsibility of such third parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this letter/report/certification.



Exceedances associated with salt-related parameters (electrical conductivity and sodium adsorption ratio), heavy metals (antimony, arsenic), and PAHs (benzo[a]pyrene, benzo[b]fluoranthene, indeno[1,2,3-cd]pyrene) were identified in the samples retrieved from the sampling locations. Based on Englobe's findings, it was advised that all soils excavated from the subject site as part of the trenching activities could not be re-used and were to be disposed of at an MECP-licensed landfill facility.

The subject property is located at 39 King Road in the City of Richmond Hill. The site is currently occupied by an existing building, a bocce court, with associated underground septic storage tank, surface tile bed, landscaping, access driveway and parking area. A review of the proposed concept plan provided by the City of Richmond Hill indicates that the bocce court and the septic system will be removed to make way for a new parking area with covered storage bins for landscape supplies. The existing driveway and parking area will be reconfigured. In addition, there will be a building addition on the east side of the existing building. The site plan, showing the approximate boundary of the subject site is shown on the Site Location Plan, Drawing No. 1.

Representative soil samples from the boreholes drilled at the subject site were collected to determine the environmental quality of material, and herein present our findings and recommendations.

Field Work

The field work, consisting of the drilling of ten (10) boreholes at the subject site, was conducted on January 29 and 30, 2025. The boreholes were advanced to depths ranging from approximately 0.1 m to 2.5 m below ground surface. The approximate borehole locations are shown on the Borehole Location Plan, Drawing No. 2.

The boreholes were advanced to the approximate depths mentioned using a drilling rig, and soil samples were retrieved from the test pits for soil classification, and visual and olfactory observations. The sampling tool (i.e., split spoon) was decontaminated prior to initial use, between the sampling locations, and at the completion of sampling activities. The sampling tool was manually scrubbed with a brush using a phosphate-free solution, and washed to remove any adhered soils, foreign material, and potential contaminants. The field work was conducted by a SEL environmental technician, who recorded the relevant findings and observations in the field.

Subsurface Profile

The boreholes were drilled on the pavement, landscape area and around the existing building. The investigation has disclosed that beneath the pavement structure, a topsoil veneer, a layer of earth fill in places, the site is underlain by strata of sand, silt and sandy silt till. Detailed descriptions of the subsurface conditions found are presented in the Borehole Logs attached, Figures 1 to 10.



Rationale for Sampling

A review of the proposed concept plan provided by the City of Richmond Hill indicates that the bocce court and the septic system will be removed to make way for a new parking area with covered storage bins for landscape supplies. The existing driveway and parking area will be reconfigured.

The recommended field work will involve drilling ten (10) boreholes (BH1 to BH10) to depths ranging from 2.7 m to 3.0 m below ground surface. The approximate borehole locations are shown on the Borehole Location Plan, Drawing No. 2.

Based on an estimated volume of 2,200 m³ of excess soils will be generated as part of the proposed residential development within the subject site. Bulk samples were analyzed to characterize the excess soil for analysis of Metals and Inorganics (M&I), Petroleum Hydrocarbons (PHCs), Volatile Organic Compounds (VOCs), and Polycyclic Aromatic Hydrocarbons (PAHs) parameters.

Site Condition Standards

For the purposes of assessing off-site re-use and/or off-site disposal options, the results of the chemical analyses were assessed against the following standards contained in the document “Rules for Soil Management and Excess Soil Quality Standards”, published by the MECP (2020), amended in 2025, and adopted by reference in Ontario Regulation (O.Reg.) 406/19 (On-Site and Excess Soil Management) made under the Environmental Protection Act, R.S.O. 1990:

- Table 1 RPIICC: Full Depth Background Site Condition Standards for Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use (hereinafter referred to as “Table 1 ESQS RPIICC Standards”).
- Table 2.1 RPI: Full Depth Excess Soil Quality Standards in a Potable Ground Water Condition for Residential/Parkland/Institutional Property Use (hereinafter referred to as “Table 2.1 ESQS RPI Standards”).
- Table 2.1 ICC: Full Depth Excess Soil Quality Standards in a Potable Ground Water Condition for Industrial/Commercial/Community Property Use (hereinafter referred to as “Table 2.1 ESQS ICC Standards”).

Soil Sampling and Quality

Representative samples were retrieved from ten (10) boreholes at the captioned site. No evidence of potential contamination was documented in any of the retrieved soil samples. Head space vapour screening was also conducted for the retrieved soil samples using a combustible gas detector (RKI Eagle) in methane elimination mode, having a minimum detection of 2 ppm (parts per million by volume). Soil vapour measurements ranging from 5 ppm to 100 ppm were recorded for the soil samples, indicating the possible presence of combustible gases in the samples retrieved from the sampling locations.



Based on the soil vapour measurements and visual and olfactory observations, representative soil samples from the sampling locations were submitted to the laboratory for chemical analyses.

The samples were sent to AGAT Laboratories, accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA), on a regular turnaround basis for chemical analysis of M&I, PHCs, VOCs, and PAHs parameters.

In addition, three (3) samples were prepared and submitted for Synthetic Precipitate Leaching Procedure (SPLP) for chemical analysis of Metals, and one (1) sample was prepared and submitted for Toxic Characteristic Leaching Procedure (TCLP) for chemical analysis of Metals, VOCs, and Polychlorinated Biphenyls (PCBs).

The details of the sampling program can be summarized as follows:

Borehole No.	Sample ID	Lab ID	Soil Type	Depth (*mbgs)	Gas Reading (**ppm)	Test(s) Conducted
1	BH 1/1	6495902	Earth Fill	0.3 - 0.8	30	M&I, PAHs
	BH 1/3	6495911	Silty Sand	1.7 - 2.3	45	PHCs, VOCs, PAHs
	BH 1/4	6495915	Silty Sand	2.4 - 3.1	20	M&I
2	BH 2/2	6495916	Earth Fill	0.9 - 1.6	15	M&I, PHCs, VOCs, PAHs
	BH 2/4	6495928	Silty Sand	2.4 - 3.1	5	M&I
3	BH 3/1	6495929	Earth Fill	0.3 - 0.8	10	M&I, PHCs, VOCs, PAHs
	BH 3/2	6495930	Earth Fill	0.9 - 1.6	15	PAHs
	BH 3/3	6495931	Earth Fill	1.7 - 2.3	35	PHCs, VOCs
4	BH 4/1	6495932	Earth Fill	0.3 - 0.8	20	M&I, PHCs, VOCs
	BH 4/2	6495933	Earth Fill	0.9 - 1.6	20	PAHs
	BH 4/3	6495934	Silty Sand	1.7 - 2.3	15	M&I, PHCs, VOCs
5	BH 5/1	6495935	Earth Fill	0.1 - 0.8	15	M&I, PAHs
	BH 5/2	6495936	Silty Sand	0.9 - 1.6	15	PHCs, VOCs
6	BH 6/1	6495938	Earth Fill	0.1 - 0.8	15	M&I, PAHs
	BH 6/3	6495973	Silty Clay	1.7 - 2.3	30	M&I, PHCs, VOCs
7	BH 7/1	6495974	Earth Fill	0.1 - 0.8	20	PHCs, VOCs, PAHs
	BH 7/2	6495975	Silty Sand	0.9 - 1.6	20	M&I, PHCs, VOCs, PAHs
8	BH 8/1	6495976	Earth Fill	0.1 - 0.8	20	M&I, PAHs
	BH 8/3	6495977	Silty Clay	1.7 - 2.3	25	PHCs, VOCs, PAHs
9	BH 9/2	6495978	Earth Fill	0.9 - 1.6	20	PHCs, VOCs, PAHs
	BH 9/3	6495979	Silty Sand	1.7 - 2.3	15	M&I
10	BH 10/1	6495980	Earth Fill	0.1 - 0.8	5	PHCs, VOCs
	BH 10/2	6495981	Silty Sand	0.9 - 1.6	100	M&I, PHCs, VOCs, PAHs
-	SPLP1	6495982	Silty Sand	-	-	SPLP Metals
-	SPLP2	6495983	Silty Sand	-	-	SPLP Metals
-	SPLP3	6495984	Silty Sand	-	-	SPLP Metals



Borehole No.	Sample ID	Lab ID	Soil Type	Depth (*mbgs)	Gas Reading (**ppm)	Test(s) Conducted
-	TCLP1	6495985	Silty Clay	-	-	TCLP Metals, TCLP VOCs, TCLP PCBs

*mbgs = meters below ground surface

**ppm = parts per million by volume

A review of the results of the soil samples indicates that the tested parameters at the tested locations meet the Table 1 ESQS RPIICC Standards, with the exception of the following parameters:

Sample ID	Parameter	Unit	Table 1 ESQS RPIICC Standards	Table 2.1 ESQS RPI Standards	Table 2.1 ESQS ICC Standards	Measured Value
BH 1/1	Electrical Conductivity	mS/cm	0.57	0.7	1.4	3.30
	Sodium Adsorption Ratio	-	2.4	5	12	11.5
BH 1/4	Electrical Conductivity	mS/cm	0.57	0.7	1.4	1.66
	Sodium Adsorption Ratio	-	2.4	5	12	12.3
BH 2/2	Electrical Conductivity	mS/cm	0.57	0.7	1.4	3.90
	Sodium Adsorption Ratio	-	2.4	5	12	19.8
BH 2/4	Electrical Conductivity	mS/cm	0.57	0.7	1.4	1.01
	Sodium Adsorption Ratio	-	2.4	5	12	10.6
BH 3/1	Electrical Conductivity	mS/cm	0.57	0.7	1.4	1.15
	Sodium Adsorption Ratio	-	2.4	5	12	10.2
BH 4/1	Sodium Adsorption Ratio	-	2.4	5	12	4.82
BH 4/3	Sodium Adsorption Ratio	-	2.4	5	12	6.87
BH 6/3	Electrical Conductivity	mS/cm	0.57	0.7	1.4	0.966
	Sodium Adsorption Ratio	-	2.4	5	12	5.35
BH 7/2	Electrical Conductivity	mS/cm	0.57	0.7	1.4	0.639
	Sodium Adsorption Ratio	-	2.4	5	12	2.82
BH 8/1	Electrical Conductivity	mS/cm	0.57	0.7	1.4	2.02
	Sodium Adsorption Ratio	-	2.4	5	12	15.5
BH 10/2	Electrical Conductivity	mS/cm	0.57	0.7	1.4	1.15
	Sodium Adsorption Ratio	-	2.4	5	12	11.9

A review of the results of the soil samples indicates that the tested parameters at the tested locations meet the Table 2.1 ESQS RPI and ICC Standards, with the exception of elevated levels of salt-related parameters electrical conductivity (EC) and sodium adsorption ratio (SAR) at the noted locations.

Salt-related contaminants (i.e., EC and SAR) were present at sampling locations BH 1/1, BH 1/4, BH 2/2, and BH 8/1 at levels exceeding all the noted MECP standards. Excess soil quality standards for parameters in soil resulting solely from the use of a substance for the safety of vehicular or pedestrian traffic applied under conditions of snow or ice or both, are deemed to be met if the following criteria are met:

1. The excess soil is finally placed at one of the following locations:



- a. Where it is reasonable to expect that the soil will be affected by the same chemicals as a result of continued application of a substance for the safety of vehicular or pedestrian traffic under conditions of snow or ice;
 - b. At an industrial or commercial property use and to which non-potable standards would be applicable; or
 - c. At least 1.5 meters below the surface of the soil.
2. The excess soil is not finally placed at any of the following locations:
 - a. Within 30 meters of a water body;
 - b. Within 100 meters of a potable water well or area with an intended property use that may require a potable water well; or
 - c. A location that will be used for growing crops or pasturing livestock unless the excess soil is placed 1.5 meters below the soil surface.

The material with elevated EC and SAR may be reused on the subject site, as long as the excess soil is finally placed in circumstances as described above. Alternatively, the material may also be taken to a regular landfill or another site for re-use purposes.

The analytical results of the Synthetic Precipitate Leaching Procedure (SPLP) analysis indicate that the tested parameters were within the leachate screening levels.

The analytical results of the TCLP analysis indicate that the tested parameters were below the Schedule 4 of the O. Reg. 558 criteria. The results confirmed that the material is classified as a non-hazardous/non-registrable waste.

The boreholes completed by Englobe Corp. along the access to the adjacent property is shown in the Combined Borehole Location Plan, Drawing No. 3.

One must be aware that soil conditions at the subject site may vary between sampling locations. Please note that the acceptance of material along with the frequency of sampling and testing are at the discretion of the receiving site. The site earthwork operations disposal of the excess soils is to be monitored under full-time inspection and reviewed by our field staff to ensure that the removed soils are consistent with the soil characterization program recently carried out and presented in this report. If indications of questionable materials or evidence of higher concentrations or other contaminants, and/or other deleterious materials are observed during site removal, the soils should be segregated for further assessment.



Should any queries arise, please feel free to contact this office.

Yours very truly,

SOIL ENGINEERS LTD.

Irfan Khan, EIT
IK/AH:ik

Ahmed Hassan, P.Eng.,



Enclosed

- Site Location Plan (1 Page, Drawing No. 1)
- Borehole Location Plan (1 Page, Drawing No. 2)
- Combined Borehole Location Plan (1 Page, Drawing No. 3)
- Borehole Logs (10 Pages, Figures 1-10)
- Certificate of Analysis (32 Pages)



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FAX: (905) 725-1315

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Enclosures



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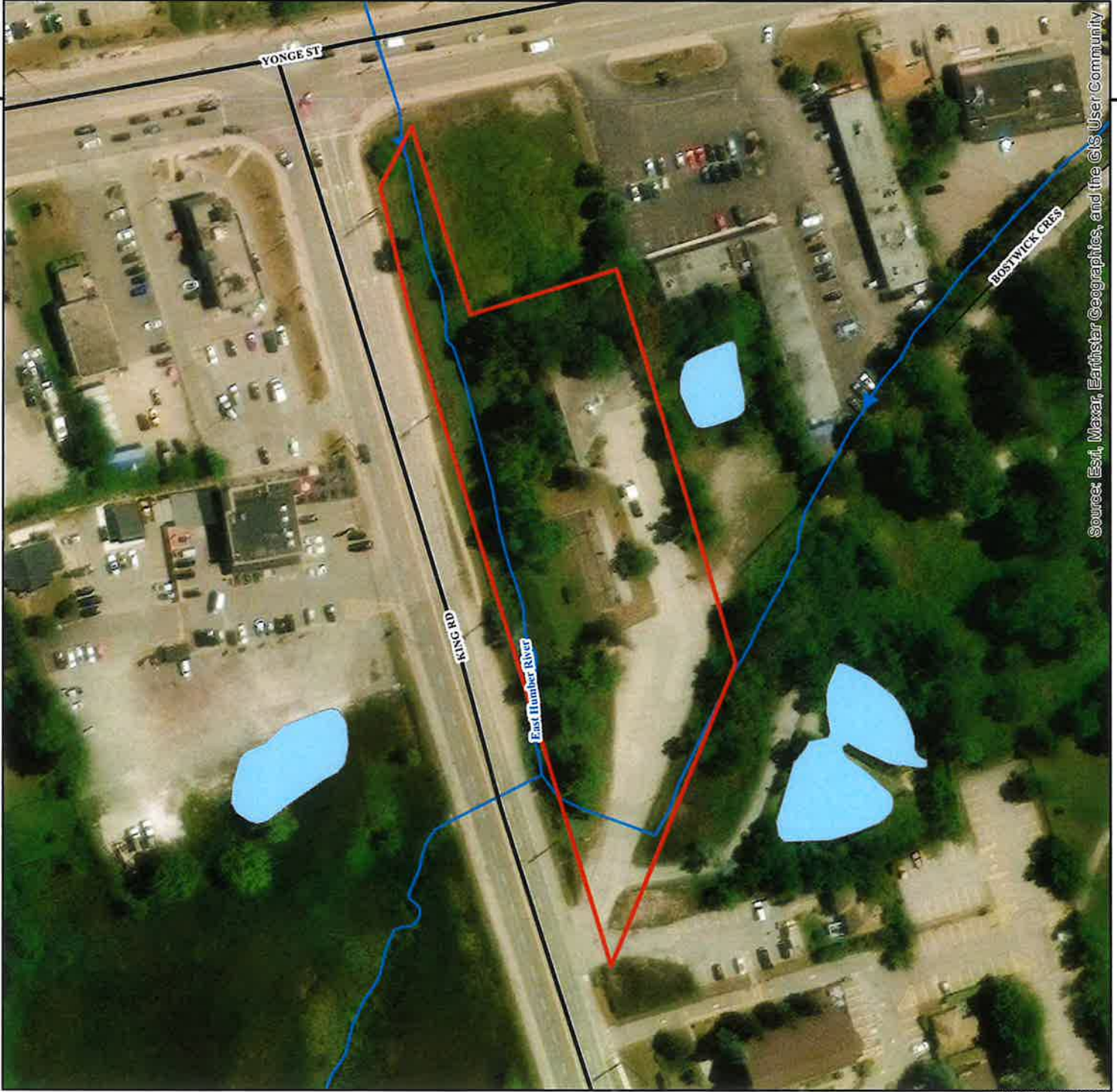
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90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 • TEL (416) 754-8515 • FAX (905) 881-8335

BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	GRAVENHURST	PETERBOROUGH	HAMILTON
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Site Location Plan

62.4000



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

62.4000



- Subject Site
- Waterbody
- Major Road
- Local Road



Title: Site Location Plan
Project: Proposed Building Redevelopment 39 King Road City of Richmond Hill
Reference No. 2501-E028
Date: February 25, 2025
Scale: 0 5 10 20 30 40 50 Metres
Drawing No. 1

Source: Ontario Ministry of Natural Resources and Forestry
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C:\GIS\2025\2501-E028\



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FAX: (905) 725-1315

NEWMARKET
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FAX: (905) 881-8335

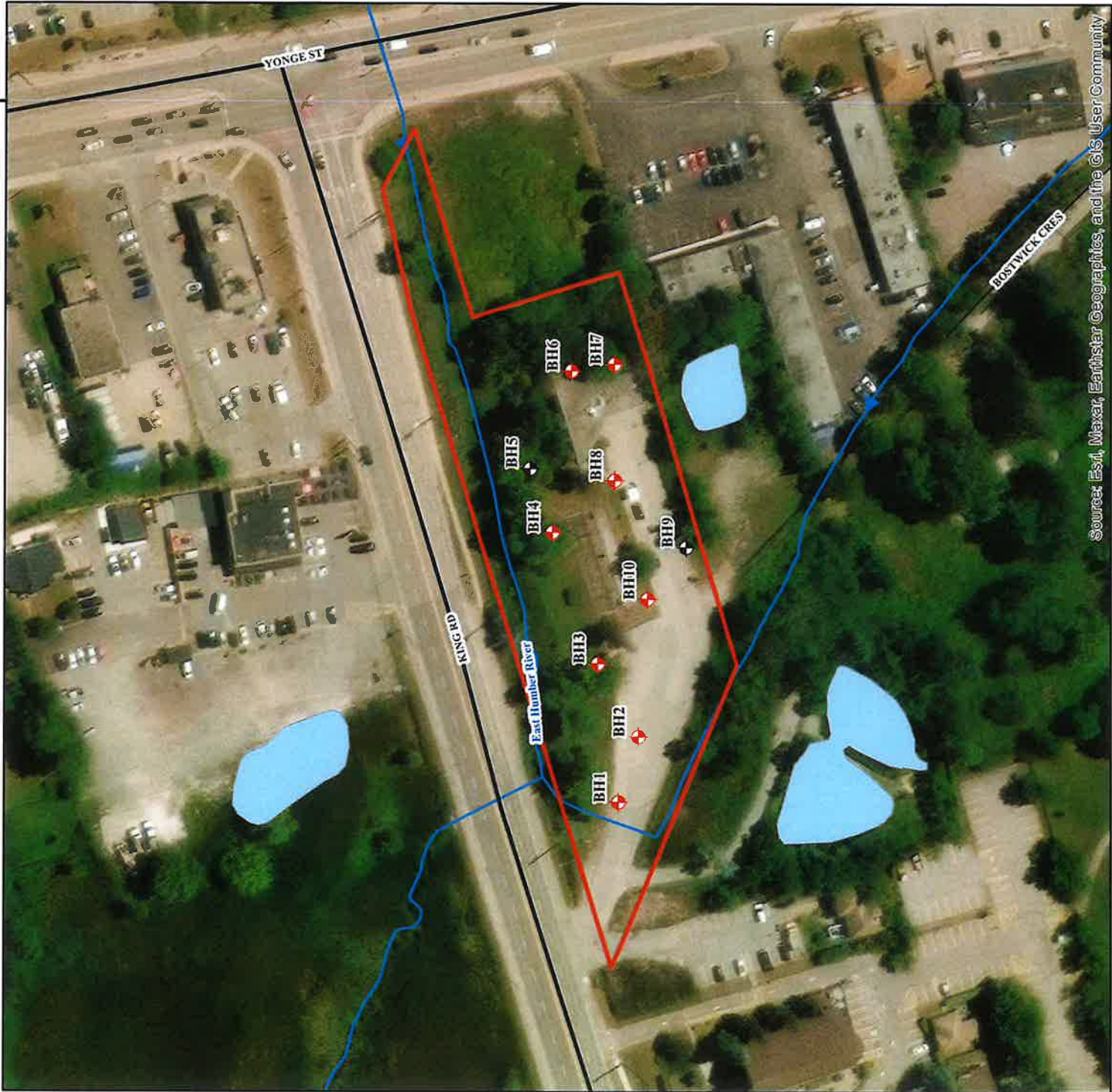
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FAX: (905) 725-1315

HAMILTON
TEL: (905) 777-7956
FAX: (905) 542-2769

Borehole Location Plan

624000




Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

624000



- Subject Site
- Borehole
- Borehole with Salt Exceeding Table 1 RPI/CC Standards
- Waterbody
- Major Road
- Local Road

 Soil Engineers Ltd.
Title: Borehole Location Plan
Project: Proposed Building Redevelopment 39 King Road City of Richmond Hill
Reference No. 2501-E028
Date: February 25, 2025
Scale: 0 5 10 20 30 40 50 Metres
Drawing No. 2



Soil Engineers Ltd.

CONSULTING ENGINEERS

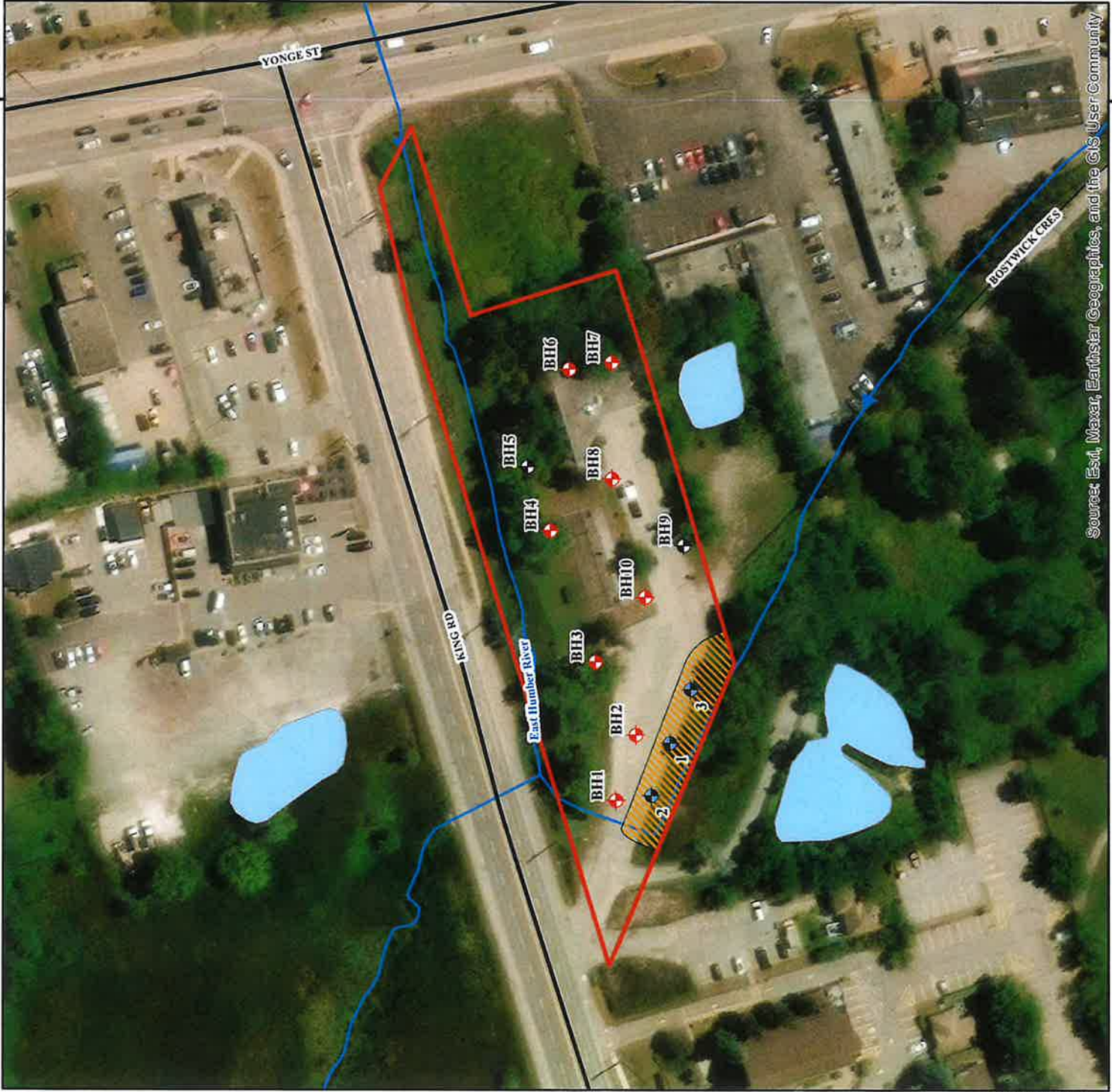
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FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 725-1315	FAX: (905) 542-2769

Combined Borehole Location Plan

624000



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

624000



- Subject Site
- Borehole
- Borehole with Salt Exceeding Table 1 RPIICC Standards
- Previous Exceeding Locations (Englobe)
- Borehole Location (Englobe)
- Waterbody
- Major Road
- Local Road



Title: Combined Borehole Location Plan
Project: Proposed Building Redevelopment 39 King Road City of Richmond Hill
Reference No. 2501-E028
Date: February 25, 2025
Scale: 0 5 10 20 30 40 50 Metres
Drawing No. 3



Soil Engineers Ltd.

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90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 • TEL (416) 754-8515 • FAX (905) 881-8335

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Certificate of Analysis

CLIENT NAME: SOIL ENGINEERS LIMITED
90 WEST BEAVER CREEK ROAD, UNIT 100
RICHMOND HILL, ON L4B 1E7
(416) 754-8515

ATTENTION TO: Ahmed Hassan

PROJECT: 2501-E028

AGAT WORK ORDER: 25T243821

SOIL ANALYSIS REVIEWED BY: Sukhwinder Randhawa, Inorganic Team Lead

TRACE ORGANICS REVIEWED BY: Neli Popnikolova, Senior Chemist

DATE REPORTED: Feb 07, 2025

PAGES (INCLUDING COVER): 32

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

***Notes**

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
- Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.
- All reportable information is available on request from AGAT Laboratories, in accordance with ISO/IEC 17025:2017, ISO/IEC 17025:2005 (Quebec), DR-12-PALA and/or NELAP Standards.
- This document is signed by an authorized signatory who meets the requirements of the MELCCFP, CALA, CCN and NELAP.
- For environmental samples in the Province of Quebec: The analysis is performed on and results apply to samples as received. A temperature above 6°C upon receipt, as indicated in the Sample Reception Notification (SRN), could indicate the integrity of the samples has been compromised if the delay between sampling and submission to the laboratory could not be minimized.



AGAT WORK ORDER: 25T243821

LABORATORIES

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

DATE RECEIVED: 2025-01-31

DATE REPORTED: 2025-02-07

SAMPLE DESCRIPTION:									
Parameter	Unit	SAMPLE TYPE:		DATE SAMPLED:		BH1/1		BH1/4	
		G / S	RDL	2025-01-29	6495902	Soil	6495915	2025-01-29	6495916
Antimony	µg/g	1.3	0.8	<0.8					
Arsenic	µg/g	18	1	3					
Barium	µg/g	220	2.0	72.5					
Beryllium	µg/g	2.5	0.5	<0.5					
Boron	µg/g	36	5	8					
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.42					
Cadmium	µg/g	1.2	0.5	<0.5					
Chromium	µg/g	70	5	18					
Cobalt	µg/g	21	0.8	5.8					
Copper	µg/g	92	1.0	13.1					
Lead	µg/g	120	1	41					
Molybdenum	µg/g	2	0.5	<0.5					
Nickel	µg/g	82	1	12					
Selenium	µg/g	1.5	0.8	<0.8					
Silver	µg/g	0.5	0.5	<0.5					
Thallium	µg/g	1	0.5	<0.5					
Uranium	µg/g	2.5	0.50	0.64					
Vanadium	µg/g	86	2.0	31.9					
Zinc	µg/g	290	5	47					
Chromium, Hexavalent	µg/g	0.66	0.2	<0.2					
Cyanide, WAD	µg/g	0.051	0.040	<0.040					
Mercury	µg/g	0.27	0.10	<0.10					
Electrical Conductivity (2:1)	ms/cm	0.57	0.005	3.30					
Sodium Adsorption Ratio (2:1)	N/A	2.4	N/A	11.5					
pH, 2:1 CaCl2 Extraction	pH Units		NA	8.16					



Certified By:



Certificate of Analysis

AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: SOIL ENGINEERS LIMITED

SAMPLING SITE: 39 King Road, Richmond Hill

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

O. Reg. 153(511) - Metals & Inorganics (Soil)									
DATE RECEIVED: 2025-01-31				DATE REPORTED: 2025-02-07					
SAMPLE DESCRIPTION:									
Parameter	Unit	SAMPLE TYPE:		BH6/1	BH6/3	BH7/2	BH8/1	BH9/3	BH10/2
		DATE SAMPLED:	RDL	Soil	Soil	Soil	Soil	Soil	Soil
	G / S	2025-01-30	2025-01-30	2025-01-30	2025-01-30	2025-01-30	2025-01-29	2025-01-29	
		6495938	6495973	6495975	6495976	6495979	6495981		
Antimony	µg/g	1.3	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	2	2	4	3	3	2
Barium	µg/g	220	2.0	61.8	57.7	48.0	55.1	63.5	35.1
Beryllium	µg/g	2.5	0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5
Boron	µg/g	36	5	6	9	13	18	7	<5
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.15	<0.10	<0.10	0.34	0.13	0.20
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	70	5	16	18	20	18	15	10
Cobalt	µg/g	21	0.8	4.5	4.7	5.9	5.6	5.6	3.0
Copper	µg/g	92	1.0	8.6	7.7	8.6	10.8	10.4	7.9
Lead	µg/g	120	1	15	5	13	15	6	15
Molybdenum	µg/g	2	0.5	<0.5	1.2	<0.5	<0.5	<0.5	<0.5
Nickel	µg/g	82	1	9	10	14	12	12	7
Selenium	µg/g	1.5	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Silver	µg/g	0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Thallium	µg/g	1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Uranium	µg/g	2.5	0.50	<0.50	0.56	<0.50	0.51	<0.50	<0.50
Vanadium	µg/g	86	2.0	24.0	24.7	39.4	26.7	25.9	16.4
Zinc	µg/g	290	5	41	25	32	56	28	33
Chromium, Hexavalent	µg/g	0.66	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide, WAD	µg/g	0.051	0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.27	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity (2:1)	mS/cm	0.57	0.005	0.149	0.966	0.639	2.02	0.174	1.15
Sodium Adsorption Ratio (2:1)	N/A	2.4	N/A	0.608	5.35	2.82	15.5	2.37	11.9
(Calc.)									
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.46	7.57	7.50	7.70	7.53	7.15



Certified By:



CLIENT NAME: SOIL ENGINEERS LIMITED

SAMPLING SITE: 39 King Road, Richmond Hill

Certificate of Analysis

AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

5835 COOPERS AVENUE
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<http://www.agatlabs.com>

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

O. Reg. 153(511) - Metals & Inorganics (Soil)	
DATE RECEIVED: 2025-01-31	DATE REPORTED: 2025-02-07

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard; Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

6495902 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl₂ extract prepared at 2:1 ratio. SAR is a calculated parameter.

6495915 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl₂ extract prepared at 2:1 ratio.

6495916-6495981 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl₂ extract prepared at 2:1 ratio. SAR is a calculated parameter.

Analysis performed at AGAT Toronto (unless marked by *)



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Certificate of Analysis

AGAT WORK ORDER: 25T243821
PROJECT: 2501-E028

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http://www.agatlabs.com

CLIENT NAME: SOIL ENGINEERS LIMITED

SAMPLING SITE: 39 King Road, Richmond Hill

ATTENTION TO: Ahmed Hassan
SAMPLED BY: Ashish

O. Reg. 406/19 - SPLP Metals									
DATE RECEIVED: 2025-01-31				DATE REPORTED: 2025-02-07					
SAMPLE DESCRIPTION:									
Parameter	Unit	SAMPLE TYPE:		SPLP 1	SPLP 2	SPLP 3	Soil	Soil	Soil
		DATE SAMPLED:							
		G / S	RDL	6495982	6495983	6495984			
Antimony Leachate	µg/L		0.6	<0.6	<0.6	<0.6			
Arsenic Leachate	µg/L		5	<5	<5	<5			
Barium Leachate	µg/L		100	<100	<100	<100			
Beryllium Leachate	µg/L		0.8	<0.8	<0.8	<0.8			
Boron Leachate	µg/L		500	<500	<500	<500			
Cadmium Leachate	µg/L		0.20	<0.20	<0.20	<0.20			
Chromium Leachate	µg/L		10	<10	<10	<10			
Cobalt Leachate	µg/L		0.3	<0.3	0.4	<0.3			
Copper Leachate	µg/L		6.9	<6.9	<6.9	<6.9			
Lead Leachate	µg/L		1.0	<1.0	2.7	<1.0			
Molybdenum Leachate	µg/L		1.5	1.9	2.7	2.8			
Nickel Leachate	µg/L		10	<10	<10	<10			
Selenium Leachate	µg/L		5.0	<5.0	<5.0	<5.0			
Silver Leachate	µg/L		0.10	<0.10	<0.10	<0.10			
Thallium Leachate	µg/L		0.5	<0.5	<0.5	<0.5			
Uranium Leachate	µg/L		2	<2	<2	<2			
Vanadium Leachate	µg/L		0.6	3.5	26.2	1.3			
Zinc Leachate	µg/L		20	<20	<20	<20			

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

6495982-6495984 Leachate for metal testing was prepared in accordance with Ontario MECP Method E9003, which has been modified from SW846-1312 by Ontario MECP. MECP has recommended that Method E9003 be used for leachate testing of soil samples under O'Reg 406/19 by MECP.

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AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

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CLIENT NAME: SOIL ENGINEERS LIMITED

SAMPLING SITE: 39 King Road, Richmond Hill

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

O. Reg. 558 - Metals & Inorganics						DATE REPORTED: 2025-02-07
DATE RECEIVED: 2025-01-31						
SAMPLE DESCRIPTION: TCLP 1						
SAMPLE TYPE: Soil						
DATE SAMPLED:						
Parameter	Unit	G / S	RDL	6495985		
Arsenic Leachate	mg/L	2.5	0.010	<0.010		
Barium Leachate	mg/L	100	0.020	0.329		
Boron Leachate	mg/L	500	0.050	<0.050		
Cadmium Leachate	mg/L	0.5	0.010	<0.010		
Chromium Leachate	mg/L	5	0.050	<0.050		
Lead Leachate	mg/L	5	0.010	<0.010		
Mercury Leachate	mg/L	0.1	0.01	<0.01		
Selenium Leachate	mg/L	1	0.020	<0.020		
Silver Leachate	mg/L	5	0.010	<0.010		
Uranium Leachate	mg/L	10	0.050	<0.050		
Fluoride Leachate	mg/L	150	0.10	0.19		
Cyanide Leachate	mg/L	20	0.05	<0.05		
(Nitrate + Nitrite) as N Leachate	mg/L	1000	0.70	<0.70		

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard; Refers to O. Reg. 558 - Schedule IV Leachate Quality Criteria

Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.
Analysis performed at AGAT Toronto (unless marked by *)



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AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

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http://www.agatlabs.com

CLIENT NAME: SOIL ENGINEERS LIMITED

SAMPLING SITE: 39 King Road, Richmond Hill

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

O. Reg. 153(511) - PAHs (Soil)									
DATE RECEIVED: 2025-01-31				DATE REPORTED: 2025-02-07					
SAMPLE DESCRIPTION:									
Parameter	Unit	SAMPLE TYPE:		BH7/1	BH7/2	BH8/1	BH8/3	BH9/2	BH10/2
		DATE SAMPLED:	G / S	RDL	Soil	Soil	Soil	Soil	Soil
		2025-01-30	2025-01-30	2025-01-29	2025-01-29	2025-01-29	2025-01-29	2025-01-29	2025-01-29
		6495974	6495975	6495976	6495977	6495978	6495981		
Naphthalene	µg/g	0.09	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	µg/g	0.093	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthene	µg/g	0.072	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluorene	µg/g	0.12	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phenanthrene	µg/g	0.69	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Anthracene	µg/g	0.16	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoranthene	µg/g	0.56	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.12
Pyrene	µg/g	1	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11
Benzo(a)anthracene	µg/g	0.36	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chrysene	µg/g	2.8	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08
Benzo(b)fluoranthene	µg/g	0.47	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07
Benzo(k)fluoranthene	µg/g	0.48	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07
Benzo(a)pyrene	µg/g	0.3	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Indeno(1,2,3-cd)pyrene	µg/g	0.23	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenz(a,h)anthracene	µg/g	0.1	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	µg/g	0.68	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
2-and 1-methyl Naphthalene	µg/g	0.59	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Moisture Content	%		0.1	12.4	13.3	16.6	10.6	11.4	15.9
Surrogate	Unit	Acceptable Limits							
Naphthalene-d8	%	50-140		75	70	80	75	75	80
Acridine-d9	%	50-140		70	95	105	75	85	80
Terphenyl-d14	%	50-140		85	70	95	95	90	70

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard; Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Industrial/Commercial/Community Property Use

Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

6495902-6495981 Results are based on the dry weight of the soil.

Note: The result for Benzo(b)Fluoranthene is the total of the Benzo(b)& Fluoranthene isomers because the isomers co-elute on the GC column.

2- and 1-Methyl Naphthalene is a calculated parameter. The calculated value is the sum of 2-Methyl Naphthalene and 1-Methyl Naphthalene.

Analysis performed at AGAT Toronto (unless marked by *)

NPaprocki

Certified By:



Laboratories

PROJECT: 2501-E028

O. Reg. 153(511) - PHCs F1 - F4 (with PAHs and VOC) (Soil)

Comments:	RDL - Reported Detection Limit;	G / S - Guideline / Standard;	Full Depth Background Site Condition Standards - Soil -
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Analysis performed at AGAT Toronto (unless marked by *)

Page 9 of 32



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Certificate of Analysis

AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

CLIENT NAME: SOIL ENGINEERS LIMITED

SAMPLING SITE: 39 King Road, Richmond Hill

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

O. Reg. 153(511) - PHCs F1 - F4 (with VOC) (Soil)									
DATE RECEIVED: 2025-01-31									
DATE REPORTED: 2025-02-07									
SAMPLE DESCRIPTION: BH3/3 BH4/1 BH4/3 BH5/2 BH6/3 BH10/1									
SAMPLE TYPE: Soil Soil Soil Soil Soil Soil									
DATE SAMPLED: 2025-01-30 2025-01-30 2025-01-30 2025-01-30 2025-01-30 2025-01-29									
G / S RDL 6495931 6495932 6495934 6495936 6495973 6495980									
Parameter	Unit	25	25	10	240	120	120	50	120
F1 (C6 to C10)	µg/g	5	5	10	50	50	50	50	50
F1 (C6 to C10) minus BTEX	µg/g	<5	<5	<5	<5	<5	<5	<5	<5
F2 (C10 to C16)	µg/g	<5	<5	<10	<50	<50	<50	<50	<50
F3 (C16 to C34)	µg/g	<50	<50	<50	<50	<50	<50	<50	<50
F4 (C34 to C50)	µg/g	<50	<50	<50	<50	<50	<50	<50	<50
Gravimetric Heavy Hydrocarbons	µg/g	NA	NA	NA	NA	NA	NA	NA	NA
Moisture Content	%	11.6	14.8	35.8	13.3	11.7	20.3		
Acceptable Limits									
Surrogate	Unit	50-140	94	97	88	90	88	78	76
Toluene-d8	%	60-140	90	78	75	81	85		
Terphenyl	%								

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard; Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Industrial/Commercial/Community Property Use

Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

6495931-6495980 Results are based on sample dry weight.

The C6-C10 fraction is calculated using toluene response factor.

C6-C10 (F1 minus BTEX) is a calculated parameter. The calculated value is F1 minus BTEX. The parameters that are components of the calculation are accredited.

The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.

Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.

The chromatogram has returned to baseline by the retention time of nC50.

Total C6 - C50 results are corrected for BTEX contribution.

This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.

nC6 and nC10 response factors are within 30% of Toluene response factor.

nC10, nC16 and nC34 response factors are within 10% of their average.

C50 response factor is within 70% of nC10 + nC16 + nC34 average.

Linearity is within 15%.

Extraction and holding times were met for this sample.

Fractions 1-4 are quantified without the contribution of PAHs. Under Ontario Regulation 153, results are considered valid without determining the PAH contribution if not requested by the client.

Analysis performed at AGAT Toronto (unless marked by *)

NPaprocki

Certified By:



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

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CLIENT NAME: SOIL ENGINEERS LIMITED

SAMPLING SITE: 39 King Road, Richmond Hill

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

O. Reg. 153(511) - VOCs (with PHC) (Soil)																			
DATE RECEIVED: 2025-01-31				DATE REPORTED: 2025-02-07															
SAMPLE DESCRIPTION:				BH1/3		BH2/2		BH3/1		BH3/3		BH4/1		BH4/3		BH5/2		BH6/3	
Parameter	Unit	SAMPLE TYPE:		2025-01-29		2025-01-29		2025-01-30		2025-01-30		2025-01-30		2025-01-30		2025-01-30		2025-01-30	
		G / S	RDL	6495911	6495916	6495929	6495931	6495932	6495934	6495936	6495973								
Dichlorodifluoromethane	µg/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Vinyl Chloride	ug/g	0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Bromomethane	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Trichlorofluoromethane	ug/g	0.25	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acetone	ug/g	0.5	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1-Dichloroethylene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Methylene Chloride	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Trans- 1,2-Dichloroethylene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Methyl tert-butyl Ether	ug/g	0.05	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,1-Dichloroethane	ug/g	0.05	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Methyl Ethyl Ketone	ug/g	0.5	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Cis- 1,2-Dichloroethylene	ug/g	0.05	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chloroform	ug/g	0.05	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,2-Dichloroethane	ug/g	0.05	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
1,1,1-Trichloroethane	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Carbon Tetrachloride	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzene	ug/g	0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
1,2-Dichloropropane	ug/g	0.05	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Trichloroethylene	ug/g	0.05	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Bromodichloromethane	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Methyl Isobutyl Ketone	ug/g	0.5	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,2-Trichloroethane	ug/g	0.05	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Toluene	ug/g	0.2	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibromochloromethane	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ethylene Dibromide	ug/g	0.05	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Tetrachloroethylene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,1,1,2-Tetrachloroethane	ug/g	0.05	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Chlorobenzene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ethylbenzene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
m & p-Xylene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Certified By:

N Popmukol



Certificate of Analysis

AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

CLIENT NAME: SOIL ENGINEERS LIMITED

SAMPLING SITE: 39 King Road, Richmond Hill

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

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O. Reg. 153(511) - VOCs (with PHC) (Soil)										
DATE RECEIVED: 2025-01-31				DATE REPORTED: 2025-02-07						
Parameter	Unit	SAMPLE DESCRIPTION:		BH1/3	BH2/2	BH3/1	BH4/1	BH4/3	BH5/2	BH6/3
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:	G / S	RDL	2025-01-29	2025-01-29	2025-01-30	2025-01-30	2025-01-30	2025-01-30
Bromoform	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Styrene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,1,2,2-Tetrachloroethane	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
o-Xylene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,3-Dichlorobenzene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,4-Dichlorobenzene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,2-Dichlorobenzene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylenes (Total)	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,3-Dichloropropene (Cis + Trans)	µg/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
n-Hexane	µg/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Moisture Content	%	0.1		15.4	14.5	16.7	14.8	35.8	13.3	11.7
Surrogate	Unit	Acceptable Limits								
Toluene-d8	% Recovery	50-140		90	90	88	97	88	90	88
4-Bromofluorobenzene	% Recovery	50-140		96	106	101	100	104	95	110

N Popovitch

Certified By:

CLIENT NAME: SOIL ENGINEERS LIMITED
SAMPLING SITE: 39 King Road, Richmond Hill

ATTENTION TO: Ahmed Hassan
SAMPLED BY: Ashish

O. Reg. 153(511) - VOCs (with PHC) (Soil)												
DATE RECEIVED: 2025-01-31				DATE REPORTED: 2025-02-07								
SAMPLE DESCRIPTION:												
Parameter	Unit	SAMPLE TYPE:		BH7/1	BH7/2	BH8/3	BH9/2	BH10/1	BH10/2			
		DATE SAMPLED:		Soil	Soil	Soil	Soil	Soil	Soil	Soil		
		G / S	RDL	2025-01-30	2025-01-30	2025-01-29	2025-01-29	2025-01-29	2025-01-29	2025-01-29	2025-01-29	
				6495974	6495975	6495977	6495978	6495980	6495981			
Dichlorodifluoromethane	µg/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Vinyl Chloride	ug/g	0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02			
Bromomethane	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Trichlorofluoromethane	ug/g	0.25	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Acetone	ug/g	0.5	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50			
1,1-Dichloroethylene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Methylene Chloride	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Trans- 1,2-Dichloroethylene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Methyl tert-butyl Ether	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
1,1-Dichloroethane	ug/g	0.05	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02			
Methyl Ethyl Ketone	ug/g	0.5	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50			
Cis- 1,2-Dichloroethylene	ug/g	0.05	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02			
Chloroform	ug/g	0.05	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04			
1,2-Dichloroethane	ug/g	0.05	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03			
1,1,1-Trichloroethane	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Carbon Tetrachloride	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Benzene	ug/g	0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02			
1,2-Dichloropropane	ug/g	0.05	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03			
Trichloroethylene	ug/g	0.05	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03			
Bromodichloromethane	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Methyl Isobutyl Ketone	ug/g	0.5	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50			
1,1,2-Trichloroethane	ug/g	0.05	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04			
Toluene	ug/g	0.2	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Dibromochloromethane	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Ethylene Dibromide	ug/g	0.05	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04			
Tetrachloroethylene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
1,1,1,2-Tetrachloroethane	ug/g	0.05	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04			
Chlorobenzene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
Ethylbenzene	ug/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			
m & p-Xylene	ug/g		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			

Certified By: *N Popmukdel*



Certificate of Analysis

AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

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CLIENT NAME: SOIL ENGINEERS LIMITED

SAMPLING SITE: 39 King Road, Richmond Hill

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

O. Reg. 153(511) - VOCs (with PHC) (Soil)									
DATE RECEIVED: 2025-01-31				DATE REPORTED: 2025-02-07					
Parameter		SAMPLE DESCRIPTION:		BH7/1		BH7/2		BH8/3	
		SAMPLE TYPE:		Soil		Soil		Soil	
		DATE SAMPLED:		2025-01-30		2025-01-30		2025-01-29	
Unit	G / S	RDL	6495974	6495975	6495977	6495978	6495980	6495981	
Bromoform	ug/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Styrene	ug/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,1,2,2-Tetrachloroethane	ug/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
o-Xylene	ug/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,3-Dichlorobenzene	ug/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,4-Dichlorobenzene	ug/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,2-Dichlorobenzene	ug/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylenes (Total)	ug/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
1,3-Dichloropropene (Cis + Trans)	ug/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
n-Hexane	ug/g	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Moisture Content	%	0.1	12.4	13.3	10.6	11.4	20.3	15.9	
Surrogate		Acceptable Limits							
Unit		50-140							
% Recovery		84							
Toluene-d8		104							
4-Bromofluorobenzene		104							
% Recovery		107							
		81							
		79							
		110							
		102							
		86							
		78							
		100							
		82							
		114							

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard; Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Industrial/Commercial/Community Property Use

Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

6495911-6495981 The sample was analyzed using the high level technique. The sample was extracted using methanol, a small amount of the methanol extract was diluted in water and the purge & trap GC/MS analysis was performed. Results are based on the dry weight of the soil.

Xylenes total is a calculated parameter. The calculated value is the sum of m&p-Xylene + o-Xylene.

1,3-Dichloropropene total is a calculated parameter. The calculated value is the sum of Cis-1,3-Dichloropropene and Trans-1,3-Dichloropropene.

The calculated parameters are non-accredited. The parameters that are components of the calculation are accredited.

Analysis performed at AGAT Toronto (unless marked by *)

N Popovitch

Certified By:



AGAT

Laboratories

Certificate of Analysis

AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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CLIENT NAME: SOIL ENGINEERS LIMITED

SAMPLING SITE: 39 King Road, Richmond Hill

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

DATE RECEIVED: 2025-01-31		O. Reg. 558 - PCBs		DATE REPORTED: 2025-02-07	
SAMPLE DESCRIPTION:		TCLP 1			
SAMPLE TYPE:		Soil			
DATE SAMPLED:		6495985			
Parameter	Unit	G / S	RDL		
PCB's Leachate	mg/L	0.3	0.005		
Surrogate	Unit	Acceptable Limits			
Decachlorobiphenyl	%	50-140	112		

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O. Reg. 558 - Schedule IV Leachate Quality Criteria
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.
6495985
The soil sample was leached using the Regulation 558 procedure. Analysis was performed on the leachate.
PCB total is a calculated parameter. The calculated value is the sum of Aroclor 1242, Aroclor 1248, Aroclor 1254 and Aroclor 1260.
Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



Certificate of Analysis

AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

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CLIENT NAME: SOIL ENGINEERS LIMITED

SAMPLING SITE: 39 King Road, Richmond Hill

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

O. Reg. 558 - VOCs				DATE REPORTED: 2025-02-07	
DATE RECEIVED: 2025-01-31		SAMPLE DESCRIPTION: TCLP 1		DATE SAMPLED:	
Parameter		Unit	G / S	RDL	6495985
Vinyl Chloride Leachate		mg/L	0.2	0.030	<0.030
1,1 Dichloroethene Leachate		mg/L	1.4	0.020	<0.020
Dichloromethane Leachate		mg/L	5.0	0.030	<0.030
Methyl Ethyl Ketone Leachate		mg/L	200	0.090	<0.090
Chloroform Leachate		mg/L	10.0	0.020	<0.020
1,2-Dichloroethane Leachate		mg/L	0.5	0.020	<0.020
Carbon Tetrachloride Leachate		mg/L	0.5	0.020	<0.020
Benzene Leachate		mg/L	0.5	0.020	<0.020
Trichloroethene Leachate		mg/L	5.0	0.020	<0.020
Tetrachloroethene Leachate		mg/L	3.0	0.050	<0.050
Chlorobenzene Leachate		mg/L	8.0	0.010	<0.010
1,2-Dichlorobenzene Leachate		mg/L	20.0	0.010	<0.010
1,4-Dichlorobenzene Leachate		mg/L	0.5	0.010	<0.010
Surrogate		Unit	Acceptable Limits		
Toluene-d8		% Recovery	50-140		
4-Bromofluorobenzene		% Recovery	50-140		

Comments: RDL - Reported Detection Limit: G / S - Guideline / Standard: Refers to O. Reg. 558 - Schedule IV Leachate Quality Criteria
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.
6495985 Sample was prepared using Regulation 558 protocol and a zero headspace extractor.
Analysis performed at AGAT Toronto (unless marked by *)

N Popmuckolof

Certified By:



AGAT Laboratories

Exceedance Summary

AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

5835 COOPERS AVENUE
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CLIENT NAME: SOIL ENGINEERS LIMITED

ATTENTION TO: Ahmed Hassan

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
6495902	BH1/1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	3.30
6495902	BH1/1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	11.5
6495915	BH1/4	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	1.66
6495915	BH1/4	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	12.3
6495916	BH2/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	3.90
6495916	BH2/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	19.8
6495928	BH2/4	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	1.01
6495928	BH2/4	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	10.6
6495929	BH3/1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	1.15
6495929	BH3/1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	10.2
6495932	BH4/1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	4.82
6495934	BH4/3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	6.87
6495973	BH6/3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	0.966
6495973	BH6/3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	5.35
6495975	BH7/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	0.639
6495975	BH7/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	2.82
6495976	BH8/1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	2.02
6495976	BH8/1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	15.5
6495981	BH10/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	1.15
6495981	BH10/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	11.9

Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 2501-E028
SAMPLING SITE: 39 King Road, Richmond Hill

AGAT WORK ORDER: 25T243821
ATTENTION TO: Ahmed Hassan
SAMPLED BY: Ashish

Soil Analysis

RPT Date: Feb 07, 2025			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

O. Reg. 153(511) - Metals & Inorganics (Soil)

Antimony	6495883		<0.8	<0.8	NA	< 0.8	110%	70%	130%	89%	80%	120%	70%	70%	130%
Arsenic	6495883		3	3	NA	< 1	127%	70%	130%	99%	80%	120%	100%	70%	130%
Barium	6495883		69.0	77.5	11.6%	< 2.0	124%	70%	130%	107%	80%	120%	119%	70%	130%
Beryllium	6495883		<0.5	<0.5	NA	< 0.5	112%	70%	130%	120%	80%	120%	126%	70%	130%
Boron	6495883		6	7	NA	< 5	95%	70%	130%	105%	80%	120%	109%	70%	130%
Boron (Hot Water Soluble)	6495883		0.22	0.23	NA	< 0.10	93%	60%	140%	103%	70%	130%	105%	60%	140%
Cadmium	6495883		<0.5	<0.5	NA	< 0.5	122%	70%	130%	107%	80%	120%	111%	70%	130%
Chromium	6495883		19	18	NA	< 5	119%	70%	130%	111%	80%	120%	105%	70%	130%
Cobalt	6495883		4.6	4.3	6.7%	< 0.8	113%	70%	130%	108%	80%	120%	108%	70%	130%
Copper	6495883		9.4	8.8	6.6%	< 1.0	103%	70%	130%	101%	80%	120%	99%	70%	130%
Lead	6495883		12	13	8.0%	< 1	115%	70%	130%	109%	80%	120%	117%	70%	130%
Molybdenum	6495883		<0.5	<0.5	NA	< 0.5	128%	70%	130%	110%	80%	120%	112%	70%	130%
Nickel	6495883		10	10	0.0%	< 1	111%	70%	130%	103%	80%	120%	101%	70%	130%
Selenium	6495883		<0.8	<0.8	NA	< 0.8	108%	70%	130%	109%	80%	120%	120%	70%	130%
Silver	6495883		<0.5	<0.5	NA	< 0.5	111%	70%	130%	103%	80%	120%	104%	70%	130%
Thallium	6495883		<0.5	<0.5	NA	< 0.5	118%	70%	130%	104%	80%	120%	107%	70%	130%
Uranium	6495883		<0.50	0.67	NA	< 0.50	117%	70%	130%	101%	80%	120%	106%	70%	130%
Vanadium	6495883		29.7	27.6	7.4%	< 2.0	123%	70%	130%	107%	80%	120%	108%	70%	130%
Zinc	6495883		48	44	7.5%	< 5	114%	70%	130%	107%	80%	120%	104%	70%	130%
Chromium, Hexavalent	6495915 6495915		<0.2	<0.2	NA	< 0.2	105%	70%	130%	90%	80%	120%	79%	70%	130%
Cyanide, WAD	6483446		<0.040	<0.040	NA	< 0.040	94%	70%	130%	103%	80%	120%	85%	70%	130%
Mercury	6495883		<0.10	<0.10	NA	< 0.10	115%	70%	130%	105%	80%	120%	115%	70%	130%
Electrical Conductivity (2:1)	6495839		0.190	0.167	12.9%	< 0.005	94%	80%	120%						
Sodium Adsorption Ratio (2:1) (Calc.)	6495883		2.17	2.32	6.7%	NA	NA								
pH, 2:1 CaCl2 Extraction	6498182		7.31	7.58	3.6%	NA	102%	80%	120%						

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Duplicate NA: results are under 5X the RDL and will not be calculated.

O. Reg. 153(511) - Metals & Inorganics (Soil)

Electrical Conductivity (2:1)	6495883		0.229	0.195	16.0%	< 0.005	95%	80%	120%
pH, 2:1 CaCl2 Extraction	6496111		7.51	7.47	0.5%	NA	102%	80%	120%

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

O. Reg. 406/19 - SPL Metals

Antimony Leachate	6501768		<0.6	<0.6	NA	< 0.6	107%	70%	130%	73%	80%	120%	70%	70%	130%
Arsenic Leachate	6501768		<5	<5	NA	< 5	111%	70%	130%	104%	80%	120%	111%	70%	130%
Barium Leachate	6501768		<100	<100	NA	< 100	111%	70%	130%	103%	80%	120%	99%	70%	130%
Beryllium Leachate	6501768		<0.8	<0.8	NA	< 0.8	107%	70%	130%	107%	80%	120%	120%	70%	130%

AGAT QUALITY ASSURANCE REPORT (V1)

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Results relate only to the items tested. Results apply to samples as received.

Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 2501-E028
SAMPLING SITE: 39 King Road, Richmond Hill

AGAT WORK ORDER: 25T243821
ATTENTION TO: Ahmed Hassan
SAMPLED BY: Ashish

Soil Analysis (Continued)

RPT Date: Feb 07, 2025			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Boron Leachate	6501768		<500	<500	NA	< 500	99%	70%	130%	109%	80%	120%	98%	70%	130%
Cadmium Leachate	6501768		<0.20	<0.20	NA	< 0.20	105%	70%	130%	98%	80%	120%	105%	70%	130%
Chromium Leachate	6501768		<10	<10	NA	< 10	103%	70%	130%	97%	80%	120%	101%	70%	130%
Cobalt Leachate	6501768		<0.3	<0.3	NA	< 0.3	105%	70%	130%	98%	80%	120%	103%	70%	130%
Copper Leachate	6501768		<6.9	<6.9	NA	< 6.9	111%	70%	130%	106%	80%	120%	110%	70%	130%
Lead Leachate	6501768		<1.0	<1.0	NA	< 1.0	109%	70%	130%	102%	80%	120%	104%	70%	130%
Molybdenum Leachate	6501768		<1.5	<1.5	NA	< 1.5	108%	70%	130%	101%	80%	120%	107%	70%	130%
Nickel Leachate	6501768		<10	<10	NA	< 10	104%	70%	130%	97%	80%	120%	103%	70%	130%
Selenium Leachate	6501768		<5.0	<5.0	NA	< 5.0	106%	70%	130%	103%	80%	120%	97%	70%	130%
Silver Leachate	6501768		<0.10	<0.10	NA	< 0.10	105%	70%	130%	96%	80%	120%	103%	70%	130%
Thallium Leachate	6501768		<0.5	<0.5	NA	< 0.5	103%	70%	130%	100%	80%	120%	96%	70%	130%
Uranium Leachate	6501768		<2	<2	NA	< 2	102%	70%	130%	98%	80%	120%	94%	70%	130%
Vanadium Leachate	6501768		0.7	0.7	NA	< 0.6	105%	70%	130%	97%	80%	120%	103%	70%	130%
Zinc Leachate	6501768		27	<20	NA	< 20	111%	70%	130%	120%	80%	120%	105%	70%	130%

Comments: NA signifies Not Applicable.
Duplicate NA: results are under 5X the RDL and will not be calculated.

More than 90% of the elements met acceptance limits and overall data quality is acceptable for use. For a multi-element scan up to 10% of analytes may exceed the quoted limits by up to 10% absolute.

O. Reg. 558 - Metals & Inorganics

Arsenic Leachate	6496816		<0.010	<0.010	NA	< 0.010	106%	70%	130%	114%	80%	120%	118%	70%	130%
Barium Leachate	6496816		0.314	0.317	1.0%	< 0.020	107%	70%	130%	110%	80%	120%	120%	70%	130%
Boron Leachate	6496816		<0.050	<0.050	NA	< 0.050	94%	70%	130%	103%	80%	120%	104%	70%	130%
Cadmium Leachate	6496816		<0.010	<0.010	NA	< 0.010	103%	70%	130%	109%	80%	120%	116%	70%	130%
Chromium Leachate	6496816		<0.050	<0.050	NA	< 0.050	107%	70%	130%	117%	80%	120%	112%	70%	130%
Lead Leachate	6496816		<0.010	<0.010	NA	< 0.010	99%	70%	130%	108%	80%	120%	104%	70%	130%
Mercury Leachate	6496816		<0.01	<0.01	NA	< 0.01	99%	70%	130%	99%	80%	120%	93%	70%	130%
Selenium Leachate	6496816		<0.020	<0.020	NA	0.133	107%	70%	130%	117%	80%	120%	116%	70%	130%
Silver Leachate	6496816		<0.010	<0.010	NA	< 0.010	105%	70%	130%	104%	80%	120%	109%	70%	130%
Uranium Leachate	6496816		<0.050	<0.050	NA	< 0.050	100%	70%	130%	117%	80%	120%	110%	70%	130%
Fluoride Leachate	6496816		0.12	0.10	NA	< 0.10	95%	90%	110%	93%	90%	110%	74%	70%	130%
Cyanide Leachate	6496816		<0.05	<0.05	NA	< 0.05	80%	70%	130%	93%	80%	120%	111%	70%	130%
(Nitrate + Nitrite) as N Leachate	6496816		<0.70	<0.70	NA	< 0.70	98%	80%	120%	94%	80%	120%	116%	70%	130%

Comments: NA signifies Not Applicable.
Duplicate NA: results are under 5X the RDL and will not be calculated.

Certified By:



AGAT QUALITY ASSURANCE REPORT (V1)

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AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. RPDs calculated using raw data. The RPD may not be reflective of duplicate values shown, due to rounding of final results.

Results relate only to the items tested. Results apply to samples as received.

Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED

PROJECT: 2501-E028

SAMPLING SITE: 39 King Road, Richmond Hill

AGAT WORK ORDER: 25T243821

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

Trace Organics Analysis

RPT Date: Feb 07, 2025

RPT Date: Feb 07, 2025			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits	Recovery	Acceptable Limits	Recovery	Acceptable Limits		
								Lower		Upper		Lower	Upper	Lower

O. Reg. 153(511) - PAHs (Soil)

Naphthalene	6495981	6495981	<0.05	<0.05	NA	< 0.05	102%	50%	140%	83%	50%	140%	80%	50%	140%
Acenaphthylene	6495981	6495981	<0.05	<0.05	NA	< 0.05	110%	50%	140%	90%	50%	140%	75%	50%	140%
Acenaphthene	6495981	6495981	<0.05	<0.05	NA	< 0.05	113%	50%	140%	83%	50%	140%	80%	50%	140%
Fluorene	6495981	6495981	<0.05	<0.05	NA	< 0.05	109%	50%	140%	90%	50%	140%	78%	50%	140%
Phenanthrene	6495981	6495981	<0.05	<0.05	NA	< 0.05	104%	50%	140%	75%	50%	140%	80%	50%	140%
Anthracene	6495981	6495981	<0.05	<0.05	NA	< 0.05	111%	50%	140%	80%	50%	140%	78%	50%	140%
Fluoranthene	6495981	6495981	0.12	0.19	NA	< 0.05	115%	50%	140%	83%	50%	140%	64%	50%	140%
Pyrene	6495981	6495981	0.11	0.17	NA	< 0.05	112%	50%	140%	88%	50%	140%	72%	50%	140%
Benzo(a)anthracene	6495981	6495981	<0.05	<0.05	NA	< 0.05	99%	50%	140%	78%	50%	140%	63%	50%	140%
Chrysene	6495981	6495981	0.08	0.12	NA	< 0.05	117%	50%	140%	95%	50%	140%	79%	50%	140%
Benzo(b)fluoranthene	6495981	6495981	0.07	0.07	NA	< 0.05	81%	50%	140%	83%	50%	140%	68%	50%	140%
Benzo(k)fluoranthene	6495981	6495981	0.07	0.08	NA	< 0.05	118%	50%	140%	83%	50%	140%	83%	50%	140%
Benzo(a)pyrene	6495981	6495981	<0.05	<0.05	NA	< 0.05	108%	50%	140%	75%	50%	140%	80%	50%	140%
Indeno(1,2,3-cd)pyrene	6495981	6495981	<0.05	<0.05	NA	< 0.05	107%	50%	140%	73%	50%	140%	88%	50%	140%
Dibenz(a,h)anthracene	6495981	6495981	<0.05	<0.05	NA	< 0.05	102%	50%	140%	75%	50%	140%	78%	50%	140%
Benzo(g,h,i)perylene	6495981	6495981	<0.05	<0.05	NA	< 0.05	96%	50%	140%	95%	50%	140%	85%	50%	140%

O. Reg. 558 - VOCs

Vinyl Chloride Leachate	6323433		<0.030	<0.030	NA	< 0.030	105%	50%	140%	112%	50%	140%	113%	50%	140%
1,1 Dichloroethene Leachate	6323433		<0.020	<0.020	NA	< 0.020	67%	50%	140%	69%	60%	130%	89%	50%	140%
Dichloromethane Leachate	6323433		<0.030	<0.030	NA	< 0.030	95%	50%	140%	90%	60%	130%	98%	50%	140%
Methyl Ethyl Ketone Leachate	6323433		<0.090	<0.090	NA	< 0.090	100%	50%	140%	111%	50%	140%	96%	50%	140%
Chloroform Leachate	6323433		<0.020	<0.020	NA	< 0.020	83%	50%	140%	108%	60%	130%	72%	50%	140%
1,2-Dichloroethane Leachate	6323433		<0.020	<0.020	NA	< 0.020	72%	50%	140%	97%	60%	130%	110%	50%	140%
Carbon Tetrachloride Leachate	6323433		<0.020	<0.020	NA	< 0.020	88%	50%	140%	91%	60%	130%	93%	50%	140%
Benzene Leachate	6323433		<0.020	<0.020	NA	< 0.020	89%	50%	140%	111%	60%	130%	112%	50%	140%
Trichloroethene Leachate	6323433		<0.020	<0.020	NA	< 0.020	85%	50%	140%	107%	60%	130%	107%	50%	140%
Tetrachloroethene Leachate	6323433		<0.050	<0.050	NA	< 0.050	102%	50%	140%	102%	60%	130%	100%	50%	140%
Chlorobenzene Leachate	6323433		<0.010	<0.010	NA	< 0.010	100%	50%	140%	106%	60%	130%	100%	50%	140%
1,2-Dichlorobenzene Leachate	6323433		<0.010	<0.010	NA	< 0.010	102%	50%	140%	86%	60%	130%	102%	50%	140%
1,4-Dichlorobenzene Leachate	6323433		<0.010	<0.010	NA	< 0.010	106%	50%	140%	82%	60%	130%	99%	50%	140%

O. Reg. 558 - PCBs

PCB's Leachate	6454698		< 0.005	< 0.005	NA	< 0.005	106%	50%	140%	89%	50%	140%	86%	50%	140%
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Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

O. Reg. 153(511) - PHCs F1 - F4 (with PAHs and VOC) (Soil)

F2 (C10 to C16)	6495981	6495981	< 10	< 10	NA	< 10	108%	60%	140%	101%	60%	140%	108%	60%	140%
F3 (C16 to C34)	6495981	6495981	< 50	< 50	NA	< 50	112%	60%	140%	102%	60%	140%	118%	60%	140%
F4 (C34 to C50)	6495981	6495981	< 50	< 50	NA	< 50	88%	60%	140%	94%	60%	140%	93%	60%	140%

AGAT QUALITY ASSURANCE REPORT (V1)

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Results relate only to the items tested. Results apply to samples as received.

Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED

PROJECT: 2501-E028

SAMPLING SITE: 39 King Road, Richmond Hill

AGAT WORK ORDER: 25T243821

ATTENTION TO: Ahmed Hassan

SAMPLED BY: Ashish

Trace Organics Analysis (Continued)

RPT Date: Feb 07, 2025			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - VOCs (with PHC) (Soil)															
Dichlorodifluoromethane	6496081		<0.05	<0.05	NA	< 0.05	92%	50%	140%	102%	50%	140%	63%	50%	140%
Vinyl Chloride	6496081		<0.02	<0.02	NA	< 0.02	114%	50%	140%	91%	50%	140%	87%	50%	140%
Bromomethane	6496081		<0.05	<0.05	NA	< 0.05	80%	50%	140%	95%	50%	140%	86%	50%	140%
Trichlorofluoromethane	6496081		<0.05	<0.05	NA	< 0.05	85%	50%	140%	113%	50%	140%	106%	50%	140%
Acetone	6496081		<0.50	<0.50	NA	< 0.50	94%	50%	140%	91%	50%	140%	95%	50%	140%
1,1-Dichloroethylene	6496081		<0.05	<0.05	NA	< 0.05	95%	50%	140%	91%	60%	130%	96%	50%	140%
Methylene Chloride	6496081		<0.05	<0.05	NA	< 0.05	70%	50%	140%	100%	60%	130%	87%	50%	140%
Trans- 1,2-Dichloroethylene	6496081		<0.05	<0.05	NA	< 0.05	87%	50%	140%	83%	60%	130%	79%	50%	140%
Methyl tert-butyl Ether	6496081		<0.05	<0.05	NA	< 0.05	98%	50%	140%	118%	60%	130%	68%	50%	140%
1,1-Dichloroethane	6496081		<0.02	<0.02	NA	< 0.02	63%	50%	140%	63%	60%	130%	80%	50%	140%
Methyl Ethyl Ketone	6496081		<0.50	<0.50	NA	< 0.50	102%	50%	140%	98%	50%	140%	94%	50%	140%
Cis- 1,2-Dichloroethylene	6496081		<0.02	<0.02	NA	< 0.02	61%	50%	140%	93%	60%	130%	92%	50%	140%
Chloroform	6496081		<0.04	<0.04	NA	< 0.04	83%	50%	140%	98%	60%	130%	100%	50%	140%
1,2-Dichloroethane	6496081		<0.03	<0.03	NA	< 0.03	76%	50%	140%	89%	60%	130%	88%	50%	140%
1,1,1-Trichloroethane	6496081		<0.05	<0.05	NA	< 0.05	60%	50%	140%	75%	60%	130%	65%	50%	140%
Carbon Tetrachloride	6496081		<0.05	<0.05	NA	< 0.05	63%	50%	140%	87%	60%	130%	96%	50%	140%
Benzene	6496081		<0.02	<0.02	NA	< 0.02	88%	50%	140%	84%	60%	130%	82%	50%	140%
1,2-Dichloropropane	6496081		<0.03	<0.03	NA	< 0.03	88%	50%	140%	70%	60%	130%	68%	50%	140%
Trichloroethylene	6496081		<0.03	<0.03	NA	< 0.03	81%	50%	140%	90%	60%	130%	98%	50%	140%
Bromodichloromethane	6496081		<0.05	<0.05	NA	< 0.05	62%	50%	140%	66%	60%	130%	84%	50%	140%
Methyl Isobutyl Ketone	6496081		<0.50	<0.50	NA	< 0.50	101%	50%	140%	84%	50%	140%	85%	50%	140%
1,1,2-Trichloroethane	6496081		<0.04	<0.04	NA	< 0.04	70%	50%	140%	72%	60%	130%	74%	50%	140%
Toluene	6496081		<0.05	<0.05	NA	< 0.05	94%	50%	140%	62%	60%	130%	64%	50%	140%
Dibromochloromethane	6496081		<0.05	<0.05	NA	< 0.05	97%	50%	140%	60%	60%	130%	87%	50%	140%
Ethylene Dibromide	6496081		<0.04	<0.04	NA	< 0.04	95%	50%	140%	99%	60%	130%	99%	50%	140%
Tetrachloroethylene	6496081		<0.05	<0.05	NA	< 0.05		50%	140%	99%	60%	130%	98%	50%	140%
1,1,1,2-Tetrachloroethane	6496081		<0.04	<0.04	NA	< 0.04	69%	50%	140%	79%	60%	130%	67%	50%	140%
Chlorobenzene	6496081		<0.05	<0.05	NA	< 0.05	81%	50%	140%	72%	60%	130%	71%	50%	140%
Ethylbenzene	6496081		<0.05	<0.05	NA	< 0.05	89%	50%	140%	69%	60%	130%	107%	50%	140%
m & p-Xylene	6496081		<0.05	<0.05	NA	< 0.05	109%	50%	140%	99%	60%	130%	98%	50%	140%
Bromoform	6496081		<0.05	<0.05	NA	< 0.05	61%	50%	140%	79%	60%	130%	94%	50%	140%
Styrene	6496081		<0.05	<0.05	NA	< 0.05	78%	50%	140%	70%	60%	130%	65%	50%	140%
1,1,2,2-Tetrachloroethane	6496081		<0.05	<0.05	NA	< 0.05	70%	50%	140%	68%	60%	130%	67%	50%	140%
o-Xylene	6496081		<0.05	<0.05	NA	< 0.05	78%	50%	140%	70%	60%	130%	65%	50%	140%
1,3-Dichlorobenzene	6496081		<0.05	<0.05	NA	< 0.05	94%	50%	140%	81%	60%	130%	77%	50%	140%
1,4-Dichlorobenzene	6496081		<0.05	<0.05	NA	< 0.05	95%	50%	140%	81%	60%	130%	77%	50%	140%
1,2-Dichlorobenzene	6496081		<0.05	<0.05	NA	< 0.05	82%	50%	140%	77%	60%	130%	72%	50%	140%
n-Hexane	6496081		<0.05	<0.05	NA	< 0.05	102%	50%	140%	64%	60%	130%	75%	50%	140%

AGAT QUALITY ASSURANCE REPORT (V1)

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Results relate only to the items tested. Results apply to samples as received.

Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 2501-E028
SAMPLING SITE: 39 King Road, Richmond Hill

AGAT WORK ORDER: 25T243821
ATTENTION TO: Ahmed Hassan
SAMPLED BY: Ashish

Trace Organics Analysis (Continued)

RPT Date: Feb 07, 2025			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits	Recovery	Acceptable Limits	Recovery	Acceptable Limits		
								Lower		Upper		Lower	Upper	Lower

Certified By:



QC Exceedance

CLIENT NAME: SOIL ENGINEERS LIMITED

AGAT WORK ORDER: 25T243821

PROJECT: 2501-E028

ATTENTION TO: Ahmed Hassan

RPT Date: Feb 07, 2025		REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Sample Id	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
			Lower	Upper		Lower	Upper		Lower	Upper

O. Reg. 406/19 - SPL Metals

Antimony Leachate

107% 70% 130% 73% 80% 120% 70% 70% 130%

Comments: NA signifies Not Applicable.

Duplicate NA: results are under 5X the RDL and will not be calculated.

More than 90% of the elements met acceptance limits and overall data quality is acceptable for use. For a multi-element scan up to 10% of analytes may exceed the quoted limits by up to 10% absolute.

Method Summary

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 2501-E028
SAMPLING SITE: 39 King Road, Richmond Hill
AGAT WORK ORDER: 25T243821
ATTENTION TO: Ahmed Hassan
SAMPLED BY: Ashish

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Arsenic	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Barium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Beryllium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Boron	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	modified from EPA 6010D and MSA PART 3, CH 21	ICP/OES
Cadmium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Chromium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Cobalt	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Copper	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Lead	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Molybdenum	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Nickel	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Selenium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Silver	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Thallium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Uranium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Vanadium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Zinc	MET 93 -6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Chromium, Hexavalent	INOR-93-6068	modified from EPA 3060 and EPA 7196	SPECTROPHOTOMETER
Cyanide, WAD	INOR-93-6052	modified from ON MOECC E3015, SM 4500-CN- I, G-387	SEGMENTED FLOW ANALYSIS
Mercury	MET-93-6103	modified from EPA 7471B and SM 3112 B	ICP-MS
Electrical Conductivity (2:1)	INOR-93-6075	modified from MSA PART 3, CH 14 and SM 2510 B	PC TITRATE
Sodium Adsorption Ratio (2:1) (Calc.)	INOR-93-6007	modified from EPA 6010D & Analytical Protocol	ICP/OES
pH, 2:1 CaCl ₂ Extraction	INOR-93-6075	modified from EPA 9045D, MCKEAGUE 3.11 E3137	PC TITRATE
Antimony Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B	ICP/MS
Arsenic Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B	ICP/MS
Barium Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B	ICP-MS
Beryllium Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B	ICP-MS
Boron Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B	ICP-MS

Method Summary

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 2501-E028
SAMPLING SITE: 39 King Road, Richmond Hill
AGAT WORK ORDER: 25T243821
ATTENTION TO: Ahmed Hassan
SAMPLED BY: Ashish

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Cadmium Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Chromium Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Cobalt Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Copper Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Lead Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Molybdenum Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Nickel Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Selenium Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Silver Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Thallium Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Uranium Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Vanadium Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Zinc Leachate	MET-93-6103	modified from EPA 1312 & EPA 6020B ICP-MS	
Arsenic Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B ICP-MS	
Barium Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B ICP-MS	
Boron Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B ICP-MS	
Cadmium Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B ICP-MS	
Chromium Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B ICP-MS	
Lead Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B ICP-MS	
Mercury Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B ICP-MS	
Selenium Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B ICP-MS	
Silver Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B ICP-MS	
Uranium Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B ICP-MS	
Fluoride Leachate	INOR-93-6000	EPA SW 846-1311; SM 4500F-C	ION SELECTIVE ELECTRODE
Cyanide Leachate	INOR-93-6052	EPA 1311 modified from MOE 3015 SM 4500 CN-I, G387	SEGMENTED FLOW ANALYSIS
(Nitrate + Nitrite) as N Leachate	INOR-93-6053	EPA SW 846-1311 & modified from SM 4500 - NO3- I	LACHAT FIA

Method Summary

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 2501-E028
SAMPLING SITE: 39 King Road, Richmond Hill
AGAT WORK ORDER: 25T243821
ATTENTION TO: Ahmed Hassan
SAMPLED BY: Ashish

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Naphthalene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Acenaphthylene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Acenaphthene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Fluorene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Phenanthrene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Anthracene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Fluoranthene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Pyrene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Benzo(a)anthracene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Chrysene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Benzo(b)fluoranthene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Benzo(k)fluoranthene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Benzo(a)pyrene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Indeno(1,2,3-cd)pyrene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Dibenz(a,h)anthracene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Benzo(g,h,i)perylene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
2-and 1-methyl Naphthalene	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Naphthalene-d8	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Acridine-d9	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Terphenyl-d14	ORG-91-5106	modified from EPA 3570 and EPA 8270E	GC/MS
Moisture Content	VOL-91-5009	modified from CCME Tier 1 Method	BALANCE
F1 (C6 to C10)	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/FID
F1 (C6 to C10) minus BTEX	VOL-91-5009	modified from CCME Tier 1 Method	P&T GC/FID
Toluene-d8	VOL-91- 5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
F2 (C10 to C16)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F2 (C10 to C16) minus Naphthalene	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F3 (C16 to C34)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F3 (C16 to C34) minus PAHs	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F4 (C34 to C50)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
Gravimetric Heavy Hydrocarbons	VOL-91-5009	modified from CCME Tier 1 Method	BALANCE
Terphenyl	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F1 (C6 to C10) minus BTEX	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/FID
F3 (C16 to C34)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID

Method Summary

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 2501-E028
SAMPLING SITE: 39 King Road, Richmond Hill
AGAT WORK ORDER: 25T243821
ATTENTION TO: Ahmed Hassan
SAMPLED BY: Ashish

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Dichlorodifluoromethane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Vinyl Chloride	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Bromomethane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Trichlorofluoromethane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Acetone	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,1-Dichloroethylene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Methylene Chloride	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Trans- 1,2-Dichloroethylene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Methyl tert-butyl Ether	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,1-Dichloroethane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Methyl Ethyl Ketone	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Cis- 1,2-Dichloroethylene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Chloroform	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,2-Dichloroethane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,1,1-Trichloroethane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Carbon Tetrachloride	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Benzene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,2-Dichloropropane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Trichloroethylene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Bromodichloromethane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Methyl Isobutyl Ketone	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,1,2-Trichloroethane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Toluene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Dibromochloromethane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Ethylene Dibromide	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Tetrachloroethylene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,1,1,2-Tetrachloroethane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Chlorobenzene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS

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Ethylbenzene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
m & p-Xylene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Bromoform	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Styrene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,1,2,2-Tetrachloroethane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
o-Xylene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,3-Dichlorobenzene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,4-Dichlorobenzene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,2-Dichlorobenzene	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Xylenes (Total)	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
1,3-Dichloropropene (Cis + Trans)	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
n-Hexane	VOL-91-5002	modified from EPA 5035A and EPA 8260D	(P&T)GC/MS
Toluene-d8	VOL-91-5002	modified from EPA 5035A & EPA 8260D	(P&T)GC/MS
4-Bromofluorobenzene	VOL-91-5002	modified from EPA 5035A & EPA 8260D	(P&T)GC/MS
PCB's Leachate	ORG-91-5112	Regulation 558, EPA SW846 3510C/8082	GC/ECD
Decachlorobiphenyl	ORG-91-5112	EPA SW846 3510C/8082	GC/ECD
Vinyl Chloride Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
1,1 Dichloroethene Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
Dichloromethane Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
Methyl Ethyl Ketone Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
Chloroform Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
1,2-Dichloroethane Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
Carbon Tetrachloride Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
Benzene Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
Trichloroethene Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
Tetrachloroethene Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
Chlorobenzene Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
1,2-Dichlorobenzene Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS

Method Summary

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PROJECT: 2501-E028

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PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
1,4-Dichlorobenzene Leachate	VOL-91-5001	EPA 1311, modified from EPA 5030C & EPA 8260D	(P&T)GC/MS
Toluene-d8	VOL-91-5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS
4-Bromofluorobenzene	VOL-91- 5001	modified from EPA 5030B & EPA 8260D	(P&T)GC/MS



Soil Engineers Ltd

CONSULTING ENGINEERS

GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE

SUBSURFACE PROFILE

DRAWING NO. 2

SCALE: AS SHOWN

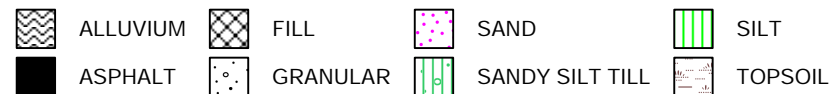
JOB NO.: 2207-S017

REPORT DATE: May 2023

PROJECT DESCRIPTION: 39 King Road, City of Richmond Hill

PROJECT LOCATION: Proposed Building Redevelopment

LEGEND



▽ WATER LEVEL (END OF DRILLING)

