
SPECIFICATIONS

The Sterling Hall School

**99 Cartwright Avenue
Toronto, Ontario**

**Issued for Tender:
July 7, 2026**

**CS&P Architects
Project No.: 21032**

Design Discipline

Documents prepared by the respective Consultants are designated by the following discipline symbols:

- Owner (O)
- Architect (A)
- Civil (C)
- Hardware Consultant (HW)
- Landscape Consultant (L)
- Structural (S)
- Mechanical Consultant (M)
- Electrical Consultant (E)
- Aquatic (AQ)

DIVISIONS 00 - 33**DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS**

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22 11 13.00	Pipes, Valves and Fittings (Plumbing System)	M	
22 11 23.29	Circulators	M	
22 13 19.13	Floor Drains	M	
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22 33 00.00	Domestic Electric Hot Water Heaters	M	
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22 42 46.00	Fixture Carriers	M	
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23 05 49.00	Seismic Force Resisting Systems	M	
23 05 93.13	Testing and Balancing Piping Systems	M	
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23 21 13.23	Piping, Valves & Fittings (Except Plumbing)	M	
23 21 23.00	Centrifugal Pumps	M	
23 22 53.00	Pressure Relief Valves	M	
23 23 01.00	Refrigerant Piping	M	
23 25 13.00	Heating System Chemical Treatment	M	
23 25 14.00	Pipe System Filters	M	
23 25 16.00	Chilled & Condenser Water Treatments	M	
23 25 26.00	Cleaning and Filling	M	
23 26 13.00	Pipe Expansion Joints, Guides and Anchors	M	
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23 31 13.00	Ductwork and Specialties	M	
23 34 33.00	Air Curtains	M	
23 37 13.00	Diffusers, Grilles and Registers	M	
23 41 16.00	Disposable Filters	M	
23 57 19.13	Heat Exchangers - Plate Type	M	
23 72 13.00	Energy Recovery Enthalpy Wheels	M	
23 72 19.00	Energy Recovery Ventilators	M	
23 73 23.13	Small Commercial Dedicated Outdoor Air System		
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23 77 13.00	Expansion Tanks	M	
23 81 29.00	Variable Refrigerant Flow (VRF) Systems	M	
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26 01 00.00	Operating and Maintenance Instructions	E	
26 05 01.00	General Instructions for Electrical Sections	E	
26 05 03.00	As-Built Drawings	E	
26 05 04.00	Submittals/Shop Drawings	E	
26 05 05.00	Mounting Heights	E	
26 05 21.00	Wires and Cables Under 2000 V	E	
26 05 26.00	Grounding + Bonding	E	
26 05 29.00	Hangers and Supports	E	
26 05 31.00	Splitters, Junction, Pull Boxes and Cabinets	E	
26 05 32.00	Outlet Boxes, Conduit Boxes and Fittings	E	
26 05 34.00	Conduits, Conduit Fasteners and Fittings	E	
26 05 36.00	Cable Trays	E	
26 05 53.00	Identification	E	
26 05 63.00	Access Doors and Accessibility	E	
26 05 73.00	Electrical Power System Studies	E	
26 05 83.00	Sleeves	E	
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26 09 13.01	Power Monitoring System – Web Based	E	
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26 24 17.00	Panelboards – Breaker Type	E	
26 27 02.00	Surge Protective Device	E	
26 27 13.00	Electronic Metering	E	
26 27 19.00	Multi-Outlet Assemblies	E	
26 27 26.00	Wiring Devices	E	
26 28 21.00	Moulded Case and Insulated Case Circuit Breakers	E	
26 28 23.00	Disconnect Switches – Fused and Non-Fused	E	
26 29 00.00	Motor Starters to 600 V	E	
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Section	Title	Discipline	Pages
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SEPARATE COVER

APPENDIX / REPORTS

- Geotechnical Investigation Report
- Multichannel Analysis of Surface Waves (MASW) Test Report
- Existing Floor Plans
- Arborist Report

END OF DOCUMENT

1 GEOTECHNICAL REPORT(S)

1.1 A copy of the following geotechnical investigation report(s) are appended to Appendices:

.1 Report on Geotechnical Investigation;
Proposed Building Addition
The Sterling Hall School
99 Cartwright Avenue
Toronto, Ontario
Prepared by: Englobe Corp.
Report No.: 02210387.006.
Dated: January 19, 2026

1.2 This report(s) records properties of the soils and recommendations for the design of foundations, prepared primarily for the use of the Consultant. The recommendations given shall not be construed as a requirement of this Contract unless also contained in the Contract Documents.

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

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

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

2 REPORT(S)

2.1 A copy of the following report(s) are appended to Appendices:

.1 Report on Multichannel Analysis of Surface Waves (MASW) Test;
The Sterling Hall School
99 Cartwright Avenue
Toronto, Ontario
Prepared by: Englobe Corp.
Report No.: 02210387.007.
Dated: February 25, 2026

2.2 The report(s), by their nature, cannot reveal all conditions that exist or can occur on the site. Should conditions be found to vary substantially from the report, immediately notify Consultant in writing and await instructions.

2.3 Contractor shall not be entitled to extra payment or extension of Contract Time for work which is required and which is reasonably inferable in the report(s) as being necessary.

END OF DOCUMENT

1 GENERAL

- 1.1 Requirements of the Articles of Agreement, Conditions of the Contract, and 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. Contractor is solely responsible for organizing division of labour and supply of materials essential to complete the Work. The Consultant and Owner assume 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 or not expressly specified or shown on Drawings, to make finished Work complete and fully operational, consistent with the intent of the Contract Documents.
- 1.4 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.
- 1.5 Conform with the requirements of the dated [...] appended to the Supplementary Conditions. Requirements applicable to "tenant contractors" apply to this Contract where applicable.
- 1.6 Specifications, Schedules and Drawings are complementary and items mentioned or indicated on one may not be mentioned or indicated on the others.
- 1.7 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.

2 SPECIFICATION LANGUAGE, STYLE, AND DEFINITIONS

- 2.1 These specifications are written in the imperative mood and in streamlined form. The imperative language is directed to Contractor, unless stated otherwise.
- 2.2 Complete sentences by reading "shall", " Contractor shall", "shall be", and similar phrases by inference. Where a colon (:) is used within sentences and phrases, read the words "shall be" by inference.
- 2.3 Fulfill and perform all indicated requirements whether stated imperatively or otherwise.

- 2.4 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.
- 2.5 Work designated as "N.I.C." is not included in this Contract.
- 2.6 When used in the context of a Product, it shall be understood the word "Provide" to mean supply, install, and connect as applicable, complete and in place including accessories, finishes, tests, and services required for a complete installation ready for its intended use.
- 2.7 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.
- 2.8 The term 'or approved alternative' following a list of Products, systems, or manufacturers used in the Contract Documents shall be construed to mean approved by Consultant. Specified products to be Base Bid. Contractor to follow 'Substitution' procedures specified in Section 01 25 00 for submitting proposed Products, systems, and manufacturers and obtain Consultant's approval of the same prior to proceeding with ordering proposed Products and systems or engaging manufacturers. Contractors who purchase Products and systems or engage manufacturers prior to Consultant's review and acceptance do so at their own risk.
- 2.9 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.
- 2.10 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.

3 **CONTRACT DOCUMENTS FOR CONSTRUCTION PURPOSES**

- 3.1 Owner will supply Contractor with a complete set of Contract Documents in electronic format before commencement of the Work. Contractor may print hard copies for construction purposes as required.

4 **DOCUMENTS AT THE SITE**

- 4.1 Keep the following documents at Place of the Work, stored securely and in good order and available to Owner and Consultant, in hard copy and/or electronic form:

- .1 Current Contract Documents, including Drawings, Specifications, and addenda.

- .2 Change Orders, Change Directives, and Supplementary Instructions.
- .3 Reviewed Shop Drawings, Product data, and samples.
- .4 Field test reports and records.
- .5 Construction progress schedule.
- .6 Meeting minutes.
- .7 Manufacturer's certifications.
- .8 Permits, inspection certificates and other documents required by authorities having jurisdiction.
- .9 Current as-built drawings.
- .10 Material Safety Data Sheets (MSDS) for all controlled Products.
- .11 Daily log including:
 - .1 Weather conditions.
 - .2 Excavation conditions
 - .3 Start and finish date of each Trade Contractor.
 - .4 Erection and removal dates of formwork.
 - .5 Date, quantities and particulars of each concrete pour.
 - .6 Dates and quantities and particulars of roofing and waterproofing work.
 - .7 Visits to the Site by Owner, Consultants, Jurisdictional Authorities, Testing and Inspection companies, and material and equipment supplier representatives.

5 **PHASING**

- 5.1 Provide a phasing plan for various stages of the Work to be implemented for the duration of the Project. Submit phasing plan for the Consultant's review.
- 5.2 The phasing plan must consider the following minimum criteria:
 - .1 Satisfy the requirements to meet the Project completion dates.
 - .2 Providing strategies to minimize disruptions to existing building operations during the construction period. Any proposed disruptions shall be subject to Owner's approval.
 - .3 All proposed work shall fully address noise, vibrations and dust/air quality resulting from the Work.
 - .4 Provision of parking needs at each phase of the Work.
 - .5 Provision of clear wayfinding and signage for pedestrian and vehicular passage for students, staff, visitors, the public and emergency personnel, when approaching and navigating the Site through each phase of the Work.

- .6 Maintain emergency and fire vehicle access routes during all phases of the Work to meet requirements of authorities having jurisdiction.

6 CONTRACT ADMINISTRATION

- 6.1 The Contract Administration office functions performed by the Consultant will generally be done through the web based contract administration software "Rform" by Re Form Technologies Ltd. (www.rform.ca).
- 6.2 The Contractor will be required to participate with the balance of the project team by using Rform for the duration of the project. Rform is a free service to the Contractor and does not require the Contractor to pay any setup or usage fees.
- 6.3 The Contractor will be provided with instructions on the access and operation of Rform in the event they are not familiar with it's function or operation. The Contractor's staff involved in the project will be provided with access to Rform at no cost to the Contractor.
- 6.4 Suppliers and Subcontractors will not be provided with access to Rform. The distribution of information issued by the Consultant, and coordination of that information, remains the responsibility of the Contractor.
- 6.5 Rform will be used for issuing electronic project related documents, including Requests for Information, Supplemental Instructions, Proposed Change Orders, Change Orders, Change Directives, Progress Claims, Certificates of Payment, Submittal Reviews, and other forms as may be required. At the discretion of the Consultant, Rform may also be used for the distribution and filing of other project related documents, including but not limited to Field Review Reports, Test Reports, Meeting Minutes, and so on. Rform will also provides automatically generated logs of documents issued within Rform.
- 6.6 The Contractor will be required to print hard copies of all project related documents issued through Rform, and to maintain files of those documents on site at all times.
- 6.7 Notwithstanding that Rform does not require signatures for the issuance and approval of documents, adjustments to the Contract Price and Contract Time in a Change Order shall only be deemed to be agreed to by the Owner and Contractor when executed by hand, and that electronic acceptance does not satisfy the conditions of agreement under GC 6.2.2 of the CCDC2 2020 Stipulated Price Contract.

7 EXISTING SITE CONDITIONS

- 7.1 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.

- 7.2 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.
- 7.3 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.

8 CONTRACTOR'S USE OF SITE

- 8.1 Except as otherwise specified, Contractor has unrestricted use of Place of the Work from time of Contract award until Ready-for-Takeover.
- 8.2 Accept full responsibility for the Work and storage areas from the time of Contract award until Ready-for-Takeover.
- 8.3 Confine Construction Equipment, Temporary Work, storage of Products, waste products and debris, and all other construction operations to limits required by laws, ordinances, permits, and Contract Documents, whichever is most restrictive. Do not unreasonably encumber Place of the Work.
- 8.4 Check means of access and egress, rights and interests which may be interfered with. Do not block lanes, roadways, entrances or exits. Direct construction traffic and locate access to site as directed by municipality.
- 8.5 Where encroachment beyond property limits is necessary make arrangements with respective property owners.

9 ACCESS/PROPERTY CONSTRAINTS

- 9.1 Owner will occupy premises during entire construction period.
- 9.2 Cooperate with Owner in scheduling operations and sequencing work to minimize disruptions and to facilitate Owner usage.

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- 9.3 Perform Work only during the following times unless otherwise approved by the Owner:
- .1 [...]
- 9.4 Provide and maintain access facilities as may be required for access to the Work.
- 9.5 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 Vancouver. Conform to City by-laws with regard to parking restrictions and other conditions.
- 9.6 Make provisions and arrangements and provide allowances if times for loading and unloading allowed by the City of Vancouver are other than regular working hours.
- 9.7 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.
- 9.8 The Work shall be confined to the area defined on the drawings and by the property lines except that services connections and certain portions of landscaping, hard paving and curb work shall be executed on Municipal property under regulation of authorities.
- 9.9 Provide locked doors in barriers, permit access by Owner and Consultant to Work areas and to areas Contractor is responsible for.
- 10 **PRODUCTS PURCHASED FROM THE OWNER**
- 10.1 Designated items as specified or indicated shall be purchased by the Contractor from the Owner, in a similar manner to items purchased by the Contractor from suppliers. Obtain information of cost and other such criteria from the Owner.
- 10.2 Products purchased from Owner include the following:
- .1 [...]
- 10.3 Coordinate pick-up with the Consultant and provide protection while stored at Site. Install completely in accordance with supplier's directions.
- 10.4 Cost of items, transportation cost and all other related costs of items purchased from Owner shall be paid by the Contractor. Receive, check, unload, handle, store and relocate such Products.
- 10.5 Coordinate and Provide necessities including mechanical and electrical requirements, for a complete installation and proper function of items purchased from Owner. Assemble, install, and clean items purchased from Owner in accordance with manufacturer's directions and connect to mechanical, electrical, and other services as applicable. Leave in full operating condition.

11 WORK BY OTHERS

11.1 Work of the Contract executed prior to the start of or during the Work of this Contract, and which is specifically excluded from this Contract:

.1 [...]

12 SECURITY

12.1 Be responsible for security of all areas affected by Work of this Contract until taken over by Owner. Take steps to prevent entry to the Work by unauthorized persons and guard against theft, fire and damage by any cause.

12.2 Provide suitable surveillance equipment and /or employ guard services, as required to adequately protect the work.

12.3 Make provisions to permit Owner's security personnel to view areas where all Work is being performed.

12.4 Use of facilities such as building entrances, washrooms, elevators and access corridors as directed by Owner's security personnel and as specified.

12.5 Take acceptable precautions to guard Work site, premises, materials and the public during and after working hours due to the Work of this Contract.

12.6 A regular full time watchman is generally not required on Site, however, if in the opinion of the Consultant the Work is not adequately protected, the Owner may request that a watchman be employed by the Contractor at no extra cost to the Contract.

12.7 Any security service provided by the Owner is for the protection of the Owner's interest in the Work on the Site and shall not relieve the Contractor of the responsibility to protect the Site and the Work of the Contract.

13 WEATHER

13.1 Incorporate into the Contract Schedule allowances for the number of working days lost due to inclement weather, which can be anticipated, on the basis of analysis of information available from Environment Canada, for weather conditions on and near the Site, over the last ten (10) years. The Contractor may be entitled to a schedule extension for those activities on the critical path which are delayed on account of inclement weather, assessed on a quarterly basis, by the number of days in excess of the anticipated number of working days for the quarter in question by more than 20%. No additional payment will be made on account of any such schedule extension.

13.2 For the purpose of this clause the quarters are defined as January 1 to March 31, April 1 to June 30, July 1 to September 30, and October 1 to December 31.

END OF SECTION

1 GENERAL

- 1.1 Allowances included herein are for items of Work which could not be fully quantified prior to Bidding.
- 1.2 Progress payments for Work and Products authorized under allowances will be made in accordance with the payment terms set out in Conditions of the Contract.
- 1.3 A schedule and scope of work shall be prepared jointly by the Consultant and Contractor to show when items called for under allowances must be authorized by the Consultant for ordering purposes so that the progress of the Work will not be delayed.
- 1.4 Submit, before application for final payment, copies of all invoices and statements from suppliers and Subcontractors for work which has been paid from cash allowances.

2 EXPENDITURE OF CASH ALLOWANCE(S)

- 2.1 Owner, through Consultant, will provide Contractor with documentation required to permit pricing of a cash allowance item.
- 2.2 Where a Cash Allowance is for work performed under a Subcontract, Owner, through Consultant, will request Contractor to identify potential Suppliers and Subcontractors, as applicable, and to obtain at least three competitive prices for each cash allowance item.
- 2.3 Contractor will provide to the Owner and Consultant bids, quotations, and other price related information received from potential Suppliers and Subcontractors complete with Contractor's recommendations for approval.
- 2.4 Owner, through Consultant, will determine by whom and for what amount each cash allowance item will be performed. Obtain Owner's prior written approval in the form of a Change Order before entering into a subcontract, amending an existing subcontract, or performing own forces work included in a cash allowance. Upon issuance of the Change Order, the Contractor's responsibilities for a cash allowance item shall be the same as for other work of the Contract.
- 2.5 Where costs under a cash allowance exceed the amount of the allowance, the Contractor will be compensated for any excess incurred and substantiated plus an allowance for overhead and profit as set out in the Contract Documents.
- 2.6 Amount of each cash allowance does not include Contractor's overhead and profit, and other related costs, which shall be included in the Contract Price and not in the cash allowance.

3 CASH ALLOWANCE(S)

- 3.1 Cash allowances, unless otherwise specified, cover the net cost to Contractor of services, Products, supply, construction machinery and equipment, freight, delivery, handling, unloading, storage, installation where indicated, all related costs, and other authorized expenses incurred in performing the Work.
- 3.2 Cash allowances shall not be included by a Subcontractor in the amount for their Subcontract work.
- 3.3 Supply only allowances shall include:
- .1 Net cost of Products as invoiced by Supplier.
 - .2 Delivery to Site.
 - .3 Applicable taxes and duties, excluding HST.
- 3.4 Supply and install allowances shall include:
- .1 Net cost of Products.
 - .2 Subcontractor's overhead and profits related to the Cash Allowance.
 - .3 Delivery, unloading, storing, handling or Products on Site.
 - .4 Installation, finishing and commissioning of Products.
 - .5 Applicable taxes and duties, excluding HST.
- 3.5 Inspection and testing allowances shall include:
- .1 Net cost of inspection and testing services.
 - .2 Applicable taxes and duties, excluding HST.
- 3.6 Other costs related to work covered by cash allowances are not covered by the allowance but shall be included in the Contract Price.
- 3.7 Include in the Bid Price the amount of each cash allowance:
- .1 [..To Follow..]: \$ [...].

4 CONTINGENCY ALLOWANCE(S)

- 4.1 Include in the Contract Price a contingency allowance in the amount of \$[...].
- 4.2 Do not include overhead and profit in the Contract Price on account of the contingency allowance. Mark-up on cost for authorized changes will be covered by the fees stated in the Bid Form.
- 4.3 Expenditures under the contingency allowance will be authorized in accordance with the Conditions of the Contract.

END OF SECTION

1.1 DEFINITION

- .1 In this Section "Substitution" means a Product, a manufacturer, or both, not originally specified in Contract Documents by proprietary name but proposed for use by Contractor in place of a Product, a manufacturer, or both, specified by proprietary name.

1.2 SUBSTITUTION PROCEDURES

- .1 Requests for Substitutions will not be accepted prior to the Notification of Award.
- .2 Contractor may only propose a Substitution wherever a Product or manufacturer is specified by proprietary name(s) and accompanied by language such as "or approved alternative", "or approved equal", or other similar words. Do not construe such language as an invitation to unilaterally provide a Substitution without Consultant's prior acceptance in writing. Do not order or install any Substitution without a Supplemental Instruction or Change Order. If the above wording is not indicated, no Substitution of a Product or manufacturer will be accepted.
- .3 Provided a proposed Substitution submission includes all of the information specified in this Section, Consultant will promptly review and accept or reject the proposed Substitution.
- .4 Substitutions will not be considered if:
 - .1 They do not meet the requirements of this Section.
 - .2 They are indicated or implied on Shop Drawings or Product data without Consultant's acceptance.
 - .3 Acceptance with require substantial revisions to the Specifications and Contract Drawings.
- .5 Consultant may accept a Substitution if satisfied that:
 - .1 the proposed substitute Product is the same type as, is capable of performing the same functions as, interfaces with adjacent work the same as, and meets or exceeds the standard of quality, performance and, if applicable, appearance and maintenance considerations, of the specified Product,
 - .2 the proposed substitute manufacturer has capabilities comparable to the specified manufacturer, and
 - .3 the Substitution provides a benefit to Owner.
- .6 If Contractor fails to order a specified Product or order a Product by a specified manufacturer in adequate time to meet Contractor's construction schedule, Consultant will not consider that a valid reason to accept a Substitution.

- .7 If Consultant accepts a Substitution and subject to Owner's agreement, the change in the Work will be documented in the form of either a Supplemental Instruction or Change Order as specified in Section 01 26 00.
- .8 If a Substitution is accepted in the form of a Supplemental Instruction or Change Order, Contractor shall not revert to an originally specified Product or manufacturer without Consultant's prior written acceptance.
- .9 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.
- .10 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.
- .11 All claims are waived for additional costs related to the substitution which may subsequently arise.

1.3 **SUBMISSION REQUIREMENTS FOR PROPOSED SUBSTITUTIONS**

- .1 Include with each proposed Substitution the following information:
 - .1 Reason(s) for proposing the Substitution and the proposed substitutions has been investigated and complete information and data as specified in this Section is submitted. Consultant will only review information and data submitted. Incomplete data will be grounds for non-acceptance.
 - .2 Identification of the Substitution, including product name and manufacturer's name, address, telephone numbers, and web site.
 - .3 Data and a statement verifying that the proposed Substitution will not affect the Contract Price and Contract Time, unless the proposed Substitution results in a decrease in the Contract Price and Contract Time. Submit data and relevant information in Request for Substitution Form appended to this Section.
 - .4 Same warranty or better is given for the substitution as for the original Product specified.
 - .5 A statement verifying that the Substitution will not affect the performance or warranty of other parts of the Work.
 - .6 Manufacturer's Product literature for the Substitution, including material descriptions, compliance with applicable codes and reference standards, performance and test data, compatibility with contiguous materials and systems, and environmental considerations.
 - .7 Product samples as applicable or requested.
 - .8 A summarized comparison of the physical properties and performance characteristics of the specified Product and the Substitution, with any significant variations clearly highlighted.

- .9 Availability of maintenance services and sources of replacement materials and parts for the Substitution, as applicable, including associated costs and time frames.
- .10 If applicable, estimated life cycle cost savings resulting from the Substitution.
- .11 Details of other projects and applications where the Substitution has been used.
- .12 Identification of any consequential changes in the Work to accommodate the Substitution and any consequential effects on the performance of the Work as a whole. A later claim for an increase to the Contract Price or Contract Time for other changes in the Work attributable to the Substitution will not be considered.

1.4 **SUBSTITUTIONS TO METHODS AND PROCESSES**

- .1 Substitutions to methods or processes 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.

END OF SECTION

1 General Information

Project Name: _____

Project #: _____ Date: _____

General Contractor: _____

Product Specified: _____ Division and Section: _____

Product Substitute: _____ Manufacturer Contact: _____

2 Proposed Substitutions

Accepted proposed substitutions will be incorporated into the Contract via a Change Order and the Contract Price will be adjusted accordingly. Proposed substitutions may be accepted or rejected at the Owner's discretion.

Provide the appropriate data for comparison showing conformance to specified standards, dimensions, fabrication, colour, quality assurance, warranty, execution etc. as necessary for the Consultant to confirm the Substituted Product meets or exceeds the specifications. At the time of this submittal, provide the Consultant with the relevant Architectural details which prove conformance with the design intent and coordination with and installation by affected trades.

Complete the following chart, so a proper comparison can be made between specified and proposed Product/assembly. Submit a separate sheet for each proposed substitution. Do not submit manufacturer's MSDS sheets as they will not be reviewed.

Specified Product	Proposed Substitution
<u>Specification Section:</u>	<u>Specification Section:</u>
<u>Detail Description:</u>	<u>Detail Description:</u>
	<u>Reason for Substitution:</u> Rationale for substitution: Schedule impact: Cost impact:

<u>Significant qualities of specified Product as applicable:</u> Size/thickness: Durability: Performance: Visual Effect: Warranty Duration:	<u>Significant qualities of proposed substitution as applicable:</u> Size/thickness: Durability: Performance: Visual Effect: Warranty Duration: (Include correlating modifications required to other work.)
	Has item been used in a similar application: Y / N Describe application:
	Changes required, if any, in other elements of the Work to accommodate proposed substitution:
	<u>Include attached as applicable to proposed substitution:</u> Drawings: Product Data: Samples: Reports: Other:

END OF FORM

1 General Information

Project Name: _____

Project #: _____ Date: _____

General Contractor: _____

Product Specified: _____ Division and Section: _____

Product Substitute: _____ Manufacturer Contact: _____

Reason for Substitution: _____

Credit: _____ Schedule Impact: _____

2 Product and Material Substitutions

In the table below provide the appropriate data for comparison as itemized in each part of the Specification Section showing conformance to specified standards, dimensions, fabrication, colour, quality assurance, warranty, execution etc. as necessary for the Consultant to confirm the Substituted Product meets or exceeds the specifications. At the time of this submittal, provide the Consultant with the relevant Architectural details which prove conformance with the design intent and co-ordination with and installation by affected trades.

Specified Product	Proposed Substitution
Part 1.0 - General	Part 1.0 - General
Part 2.0 - Product	Part - Product
Part 3.0 - Execution	Part 3.0 - Execution

1.1 SCHEDULE OF LABOUR RATES

- .1 Prior to the first application for payment, submit for the Consultant's review a schedule of labour rates for all trades and classifications of trades, such as journeymen, apprentices, and foremen that will be employed in the Work. Provide a breakdown of payroll burden component of labour rates.
- .2 Labour rates shall reflect the salaries, wages, and benefits paid to personnel in the direct employ of the Contractor, Subcontractors, and sub-Subcontractors, stated as hourly rates, that will be used when:
 - .1 Preparing price quotations for Change Orders, and
 - .2 Determining the cost of work attributable to Change Directives.
- .3 Labour rates stated in the schedule of labour rates shall be consistent with rates that will actually be paid, and payroll burden costs that will actually be incurred, in the normal performance of the Work, during regular working hours. Labour rates shall not include any additional overhead and profit component.
- .4 Where collective agreements apply, the labour rates shall not exceed those established by collective agreement.
- .5 Obtain the Owner's written acceptance of the schedule of labour rates before submitting the first Change Order quotation.
- .6 Accepted schedule of labour rates will be used solely for evaluating Change Order quotations and cost of performing work attributable to Change Directives.
- .7 The Contractor may request amendments to the accepted schedule of labour rates if changes in the labour rates that will actually be paid, or payroll burden cost that will actually be incurred, in the normal performance of the Work can be demonstrated. Obtain the Owner's written acceptance of such changes.

1.2 SCHEDULE OF EQUIPMENT RATES

- .1 Prior to the first application for payment, submit for the Consultant's review a schedule of equipment rates for Contractor owned Construction Equipment.
- .2 Equipment rates shall reflect the rates that will be used when:
 - .1 Preparing price quotations for Change Orders, and
 - .2 Determining the cost of work attributable to Change Directives.
- .3 Equipment rates stated in the schedule shall be consistent with local equipment rental market rates and shall not include any additional overhead and profit component.
- .4 Obtain the Owner's written acceptance of the schedule of equipment rates before submitting the first Change Order quotation.

- .5 Accepted schedule of equipment rates will be used solely for evaluating Change Order quotations and cost of performing work attributable to Change Directives.
- .6 The Contractor may request amendments to the accepted schedule of equipment rates if changes in local equipment rental market rates can be demonstrated. Obtain the Owner's written acceptance of such changes.

1.3 VALUATION OF CHANGES BASED ON AGREED UNIT PRICES

- .1 The Consultant may, at the outset of the Contract or at any other time, request the Contractor to submit unit prices anticipated to be required in valuing changes in the Work.
- .2 The Contractor shall submit such unit prices promptly upon request.
- .3 The unit prices shall be valid for a specified duration.
- .4 The unit prices shall exclude all fees for overhead and profit and shall be subject to the percentage fees specified in this Section under Fees for Overhead and Profit – Change Orders.
- .5 The Consultant will evaluate the Contractor's quoted unit prices and, if accepted by the Owner in writing, the agreed unit prices shall be used to value subsequent proposed changes in the Work wherever they are applicable.

1.4 METHOD OF CONTRACT PRICE ADJUSTMENT - CHANGE ORDERS

- .1 Unless otherwise agreed, the adjustment of the Contract Price on account of a proposed change in the Work shall be based on a quotation for a fixed price increase or decrease to the Contract Price regardless of the Contractor's actual expenditures and savings.
- .2 If unit prices included in the stipulated price contract are applicable to the proposed change, the adjustment of the Contract Price shall be based on those unit prices, to the extent they apply. If the actual quantities to which the unit prices apply vary from the estimated quantities by more than 20 %, the unit prices shall be subject to negotiation.

1.5 CHANGE ORDER PROCEDURES

- .1 Upon issuance by the Consultant to the Contractor of a proposed change in the Work, and unless otherwise requested in the proposed change or unless otherwise agreed:
 - .1 Submit to the Consultant a fixed price quotation for the proposed change in the Work within 5 days after receipt of the proposed change in the Work.
 - .2 If requested in the proposed change, provide a detailed breakdown of the price quotation including the following to the extent applicable, with appropriate supporting documentation:
 - .1 Estimated labour costs, including hours and applicable hourly rates based on the accepted schedule of labour rates.
 - .2 Estimated Product costs, including Supplier quotations, estimated quantities and unit prices.
 - .3 Estimated Construction Equipment costs.
 - .4 Enumeration of all other estimated costs included in the price quotation.
 - .5 Estimated credit amounts for labour and Products not required on account of the proposed change.
 - .6 Fees, not exceeding the applicable percentages for overhead and profit as specified in this Section.
 - .7 Where applicable, Subcontractor quotations, also including a detailed breakdown of all of the above.
 - .3 Include in the quotation the increase or decrease to the Contract Time, if any, for the proposed change, stated in number of days.
 - .4 Include in the quotation the number of days for which the quotation is valid.
 - .5 The quotation will be evaluated by the Consultant and the Owner and, if accepted by the Owner, be documented in the form of a signed Change Order.

1.6 FEES FOR OVERHEAD AND PROFIT – CHANGE ORDERS

- .1 Where the Contractor's price quotation for a Change Order results in a net increase to the Contract Price, the Contractor's entitlement to a fee for overhead and profit in the quotation shall be as follows, as applicable:
 - .1 For work to be performed by the Contractor's own forces, 10 % of the Contractor's price quotation before the Contractor's fee is applied.
 - .2 For work to be performed by a Subcontractor, 5 % of the Subcontractor's price quotation including the Subcontractor's fee.

- .2 Where a Subcontractor's price quotation for a Change Order results in a net increase to the Subcontractor's contract price, the Subcontractor's entitlement to a fee for overhead and profit in the quotation shall be as follows, as applicable:
 - .1 For work to be performed by the Subcontractor's own forces, 10 % of the Subcontractor's price quotation before the Subcontractor's fee is applied.
 - .2 For work to be performed by a sub-Subcontractor, 5 % of the sub-Subcontractor's price quotation including the sub-Subcontractor's fee.
- .3 Where the Contractor's or a Subcontractor's price quotation for a Change Order results in a net decrease in price before adjustment for fees for overhead and profit, such a price quotation shall be for the net decrease without any adjustment for fees for overhead and profit.

1.7 **METHOD OF CONTRACT PRICE ADJUSTMENT - CHANGE DIRECTIVES**

- .1 Unless the Owner and the Contractor reach an earlier agreement on the adjustment to the Contract Price by means of a Change Order that cancels the Change Directive, the adjustment in the Contract Price for change carried out by way of a Change Directive shall be determined as specified in the General Conditions of Contract after the change in the Work is completed.

1.8 **CHANGE DIRECTIVE PROCEDURES**

- .1 If a Change Directive is issued for a change in the Work for which a proposed change was previously issued, but no Change Order has yet been signed, the Change Directive shall cancel the proposed change and any Contractor quotations related to that change in the Work.
- .2 When proceeding with a change in the Work under a Change Directive, keep accurate records of daily time sheets for labour and Construction Equipment, and invoices for Product and Construction Equipment costs. Submit such records to the Consultant daily, until the Change Order superseding the Change Directive is issued.

1.9 **FEES FOR OVERHEAD AND PROFIT – CHANGE DIRECTIVES**

- .1 The Contractor's entitlement to a fee for overhead and profit on the Contractor's expenditures and savings attributable to a Change Directive shall be as follows, as applicable:
 - .1 For work performed by the Contractor's own forces, 10 % of the Contractor's net increase in costs.
 - .2 For work performed by a Subcontractor, 5 % of the sum of the Subcontractor's net increase in costs plus the Subcontractor's fee.

- .2 A Subcontractor's entitlement to a fee for overhead and profit on the Subcontractor's expenditures and savings attributable to a Change Directive shall be as follows, as applicable:
 - .1 For work performed by the Subcontractor's own forces, 10 % of the Subcontractor's net increase in costs.
 - .2 For work performed by a Sub-subcontractor, 5 % of the sum of the Sub-subcontractor's net increase in costs plus the Sub-subcontractor's fee.
- .3 Where a Change Directive results in net savings on account of work not required to be performed and a net decrease in the Contractor's or Subcontractor's cost, the net savings to the Contractor or Subcontractor shall be calculated without any adjustment for fees for overhead and profit.
- .4 When a Change Directive is ultimately recorded as a Change Order, there shall be no additional entitlement to fees for overhead and profit beyond those specified in this article.

1.10 **SUPPLEMENTAL INSTRUCTIONS**

- .1 The Consultant may issue Supplemental Instructions to provide clarifications to the Contract Documents, provide additional information, or make minor variations in the Work not involving adjustment in the Contract Price or Contract Time.
- .2 If the Contractor considers a Supplemental Instruction to require an adjustment in Contract Price or Contract Time, the Contractor shall promptly notify the Consultant and the Owner in writing and shall not proceed with any work related to the Supplemental Instruction pending receipt of a Change Order, a Change Directive, or, in accordance with the dispute resolution provisions of the General Conditions of Contract, a Notice in Writing of a dispute and instructions to proceed.

END OF SECTION

1.1 REQUEST FOR INTERPRETATION (RFI)

- .1 A Request for Interpretation (RFI) is a formal process used during the Work to obtain an interpretation of the Contract Documents or to obtain additional information.
- .2 An RFI shall not constitute notice of claim for a delay.

1.2 SUBMITTAL PROCEDURES

- .1 Number RFIs consecutively in one sequence in order submitted, in numbering system as established by the Contractor and agreed to by the Consultant.
- .2 Submit one distinct subject per RFI form. Do not combine unrelated items on one form.
- .3 RFI form:
 - .1 Submit RFIs to the Contractor on "Request for Interpretation" form, appended to this Section. The Consultant shall not respond to an RFI except as submitted on this form.
 - .2 Where RFI form does not have sufficient space to provide complete information thereon, attach additional sheets as required.
 - .3 Submit with RFI form all necessary supporting documentation.
- .4 RFI log:
 - .1 Maintain log of RFIs sent to and responses received from the Consultant, complete with corresponding dates.
 - .2 Submit updated log of RFIs with each application for payment submission.
- .5 Submit RFIs sufficiently in advance of affected parts of the Work so as not to cause delay in the performance of the Work. Costs resulting from failure to do so will not be paid by the Owner.
- .6 Only the Contractor shall submit RFIs to the Consultant.
- .7 RFIs submitted by Subcontractors or Suppliers directly to the Consultant shall not be accepted.

1.3 SCREENING OF RFIs

- .1 Subcontractor and Contractor shall satisfy themselves that an RFI is warranted by undertaking a thorough review of the Contract Documents to determine that the claim, dispute, or other matters in question relating to the performance of the Work or the Interpretation of the Contract Documents cannot be resolved by direct reference to the Contract Documents.

- .2 Contractor shall describe in detail this review on the RFI form as part of the RFI submission. RFI submittals that lack such detailed review description, or where the detail provided is, in the opinion of the Consultant, insufficient, shall not be reviewed by the Consultant and shall be rejected.

1.4 **RESPONSE TO RFI**

- .1 Consultant shall review RFIs from the Contractor submitted in accordance with this Section with the following understandings:
 - .1 Consultant's response shall not be considered as a Change Order or Change Directive, nor does it authorize changes in the Contract Price or Contract Time or changes in the Work.
 - .2 Only the Consultant shall respond to RFIs. Responses to RFIs received from entities other than the Consultant shall not be considered valid.

1.5 **RESPONSE TIMING**

- .1 Allow 5 Working Days for review of each RFI by the Consultant.
- .2 Consultant's review of RFI commences on date of receipt of RFI submission by the Consultant from Contractor and extends to date RFI returned by Consultant.
- .3 When the RFI submission is received by Consultant before noon, review period commences that day. When RFI submittal is received by Consultant after noon, review period begins on the next Working Day.
- .4 If, at any time, the Contractor submits a large enough number of RFIs or the Consultant considers the RFI to be of such complexity that the Consultant cannot process these RFIs within 5 Working Days, the Consultant, will confer with the Contractor and the originator of the RFI within 3 Working Days of receipt of such RFIs, and the Consultant, the Contractor, and the originator will jointly prepare an estimate of the time necessary for processing same as well as an order of priority among the RFIs submitted. The Contractor and originator shall accommodate such necessary time at no increase in the Contract Time and at no additional cost to the Owner.

END OF SECTION

RFI Number: RFI-

Date Prepared:

File:

Contractor:

RFI from:

Attention:

RFI Item	Question	Spec/Detail Ref
1	List RFI items here or refer to attached RFI document from contractor.	

Note: The following response provides an answer to the request for information noted herein. Proceeding with work in accordance with this response indicates the *Contractor's* acknowledgment that there will be no change in the *Contract Price* and/or *Contract Time*. If the *Contractor* believes that this response affects the *Contract Price* or *Contract Time*, the *Contractor* shall promptly notify the *Consultant*.

RFI Item	Response

RFI Response by:

Date:

Attachments

list attachments or state "none"

1.1 **SCHEDULE OF VALUES**

- .1 Prior to the first application for payment, submit for Consultant's review an initial schedule of values. Modify the initial schedule of values if and as requested by Consultant. Obtain Consultant's written acceptance of the initial schedule of values prior to the first application for payment.
- .2 Together with the first and all subsequent applications for payment, submit updated versions of the schedule of values to indicate the values, to the date of application for payment, of work performed and Products delivered to Place of the Work.
- .3 Provide the schedule of values in an electronic spreadsheet format based on a format acceptable to all parties to the Contract, that provides for inclusion of the following information:
 - .1 Identifying information including title and location of the Work, name of Contractor, number and date of application for payment, and period covered by the application for payment.
 - .2 A work breakdown structure that is sufficiently detailed and comprehensive to facilitate Consultant's evaluation of applications for payment at an appropriate level of detail.
 - .3 Provisions for approved Change Orders, allowances, and other relevant values, so that the breakdown amounts indicated in the schedule of values aggregate to the current total Contract Price. Also provide for indicating the estimated value of Change Directives within the schedule of values, separately from the current total Contract Price.
 - .4 For each item in the work breakdown structure, provide as a minimum the following information, under headings as indicated:
 - .1 Breakdown Amount: A dollar amount, including an appropriate pro rata portion of Contractor's overhead and profit.
 - .2 Performed to Date: The value of Work performed and Products delivered to Place of the Work up to the date of the application for payment, stated as a percentage of the Contract Price and in dollars.
 - .3 Previously Performed: The value of Work performed and Products delivered to the Place of the Work for which payment has been previously certified, stated in dollars.
 - .4 Current Period: The value of Work performed and Products delivered to Place of the Work for which Contractor is currently applying for payment, stated in dollars.
 - .5 Balance to Complete: The value of Work not yet performed and Products not yet delivered to Place of the Work, stated in dollars.

1.2 CASH FLOW PROJECTION

- .1 Prior to the first application for payment submit, for Consultant's review, a forecast of approximate monthly progress payments for each month of the Contract Time.
- .2 Submit revised cash flow forecasts on a monthly basis when required due to significant changes in rate of progress of the Work or significant changes in the Contract Price or as requested by Consultant.

1.3 WORKERS' COMPENSATION CLEARANCE

- .1 Submit proof of workers' compensation clearance with each application for payment.

1.4 STATUTORY DECLARATIONS

- .1 Submit a statutory declaration in the form of CCDC 9A – Statutory Declaration of Progress Payment Distribution by Contractor with each application for payment except the first.

END OF SECTION

1 **GENERAL**

- 1.1 Coordination of the Work of all Sections of the specifications as required to complete the Project is the responsibility of the Contractor.
- 1.2 Cooperate and coordinate with Other Contractors including Other Contractor's employed by Owner.
- 1.3 Ensure that Subcontractors and trades cooperate with other subcontractors and trades whose work attaches to or is affected by their own work. Ensure that minor adjustments are made to make adjustable work fit fixed work.
- 1.4 Allow access of Owner's Other Contractors on site and to areas of Work. Cooperate and coordinate with such Other Contractors. Schedule work to complement work of such Other Contractors.
- 1.5 Entry by the Owner's own forces and by Other Contractors shall not mean acceptance of the Work and shall not relieve the Contractor of their responsibility to complete the Contract.
- 1.6 Placing, installation, application and connection of work by the Owner's own forces or by Other Contractors on and to the Contractor's Work shall not relieve the Contractor of his responsibility to provide and maintain the specified warranties.
- 1.7 Coordinate with removals/installations specified in other Divisions and Other Contracts.
- 1.8 Coordination of the installation of systems specified in Divisions 13, 21, 22, 23 and 26, including the interrelating operation and functioning between components of a system and between systems, is the responsibility of those performing the work of those Divisions, with final coordination the responsibility of the Contractor.
- 1.9 Coordinate relocation of existing mechanical and electrical items with work specified in Divisions 13, 21, 22, 23, and 26.
- 1.10 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.
- 1.11 Pay particular attention to types of ceiling construction and clearances throughout, especially where recessed fixtures are required. Coordinate work with Other Contractors and Subcontractors wherever ventilation ducts or piping installations occur to ensure that conflicts are avoided.
- 1.12 Install ceiling mounted components in accordance with final ceiling plans. Inform Consultant of conflicting installations.

-
- 1.13 Install and arrange ducts, piping, tubing, conduit, equipment, fixtures, materials and product to conserve headroom and space with minimum interference and in neat, orderly and tidy arrangement. Run pipes, ducts, tubing and conduit, vertical, horizontal and square with building grid unless otherwise indicated. Install piping, ducts, and conduit as close to underside of structure as possible unless shown otherwise.
- 1.14 Make provision, without interference or restriction by items located within the ceiling space, for unrestricted relocation of light fixtures to replace ceiling panels at grid spaces of the same size.
- 1.15 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. Have cutting, drilling and other remedial work, and the subsequent patching or other work required for failing to comply with this requirement, performed at a later date at no additional Cost to Owner.
- 1.16 Properly coordinate the work of the various Sections and trades, taking into account 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. Proceed with work in these areas only as, and when directed by the Consultant.
- 1.17 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.
- 1.18 In case of damage to active services on 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. Costs to be borne by the Contractor.
- 2 METRIC DIMENSIONS**
- 2.1 Measurements in this specification are expressed in metric (SI) units and depending on the progress made in the various sectors of the industry are either hard or soft converted units.
- 2.2 All metric units specified shall be taken to be the minimum acceptable unless otherwise noted.

2.3 It is the Contractor's responsibility to check and verify with manufacturers and suppliers on the availability of materials and products in either metric or imperial sizes. Be responsible for coordinating products supplied in metric (SI) and imperial units into the overall layout.

2.4 Where both metric and imperial sizes or dimensions are shown, the metric size or dimension shall govern.

3 BUILDING DIMENSIONS

3.1 Take necessary job dimensions for the proper execution of the work. Assume complete responsibility for the accuracy and completeness of such dimensions, and for coordination.

3.2 Verify that work, as it proceeds, is executed in accordance with dimensions and positions indicated which maintain levels and clearances to adjacent work, as set out by requirements of the Drawings, and ensure that work installed in error is rectified before construction resumes.

3.3 Check and verify dimensions referring to the work and the interfacing of services.

3.4 Do not scale directly from the Drawings. If there is ambiguity or lack of information, immediately inform the Consultant. Changes required through the disregarding of this clause shall be the responsibility of the Contractor.

3.5 All details and measurements of any work which is to fit or to conform with work installed shall be taken at the building.

3.6 Advise Consultant of discrepancies and if there are omissions on Drawings, particularly reflected ceiling plans and jointing patterns for surfaces finishes, which affect aesthetics, or which interfere with services, equipment or surfaces. Do not proceed with work affected by such items without direction from the Consultant.

3.7 Provide written requirements for site conditions and surfaces necessary for the execution of respective work, and provide setting drawings, templates and all other information necessary for the location and installation of material, holes, sleeves, inserts, anchors, accessories, fastenings, connections and access panels. Inform respective contractors whose work is affected by these requirements and preparatory work.

4 INTERFERENCE AND COORDINATION DRAWINGS

4.1 Coordinate placement of equipment to ensure that components will be properly accommodated within the spaces provided prior to commencement of work.

4.2 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the spaces provided. Provide copies of interference drawings to Consultant when requested by Consultant.

4.3 Prepare drawings to indicate coordination and methods of installation of a system with other systems where their relationship is critical. Ensure that all details of equipment apparatus, and connections are coordinated.

4.4 Take complete responsibility for any remedial work that results from failure to coordinate any aspect of the Work prior to its fabrication/installation.

4.5 Ensure that accesses and clearance required by jurisdictional authorities and/or for easy maintenance of equipment are provided in the layout of equipment and services.

5 SLEEVING AND INSERT DRAWINGS AND TEMPLATES

5.1 Prepare sleeving drawings for work of Divisions 13, 21, 22, 23, and 26, showing size and location of all penetrations through load bearing elements. Submit sleeving drawings in the form of one transparency and 4 prints to Consultant for review not less than 15 days prior to construction of affected elements.

5.2 Prepare insert setting drawings for work to be cast into concrete and/or mortared into masonry elements. Submit insert setting drawings in the form of a transparency and 4 prints to Consultant for review not less than 15 days prior to construction of affected elements.

5.3 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.

5.4 Provide cutting, fixing and making good to the work of Other Contractors, Subcontractors and trades as required for sleeving and inserts and make up time lost as a result of failure to comply with this requirement, at no additional cost to the Owner.

END OF DOCUMENT

1 CONSTRUCTION START-UP MEETING

- 1.1 Promptly after Contract award, Contractor shall establish the time and location of a construction start-up meeting to review and discuss administrative procedures and responsibilities. Contractor shall notify Consultant at least 5 Working Days before the meeting.
- 1.2 Contractor will prepare and distribute copies of Agenda prior to meeting.
- 1.3 Senior representatives of Owner, Consultant(s), and Contractor, including Contractor's project manager and site superintendent, and major Subcontractors, shall be in attendance.
- 1.4 Consultant will arrange attendance of other interested parties not responsible to the Contractor.
- 1.5 Be prepared to provide specific information relative to agenda items as they are pertinent to the Contract.
- 1.6 Contractor's representative will chair the meeting and record and distribute the minutes within 5 Working Days of meeting date.
- 1.7 Agenda will include but not be limited to the following topics as are pertinent to the Contract.
 - .1 Review project communications procedures.
 - .2 Contract Documents for construction purposes.
 - .3 Construction progress meetings.
 - .4 Review contract administration requirements including submittals, cash allowances, payment, and change modification procedures.
 - .5 Construction progress schedule, including long lead time items for positive action.
 - .6 Submittals schedule and procedures.
 - .7 Identify any product availability problems and substitution requests.
 - .8 Contractor's mobilization and construction facilities.
 - .9 Establish work restrictions, site arrangements, and temporary facilities.
 - .10 Review Consultants inspection requirements.
 - .11 Quality requirements, including testing and inspection procedures.
 - .12 Temporary controls, utilities, barriers and enclosures.

- .13 Field engineering and layout of work.
- .14 Site safety and security.
- .15 Cleaning and waste management.
- .16 Review any points which, in Owner's, Consultants, and Contractor's opinion, require clarification.

2 CONSTRUCTION PROGRESS MEETINGS

- 2.1 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. Contractor shall notify Consultant at least 5 Working Days before the meeting.
- 2.2 Contractor to arrange for and provide physical space for meetings.
- 2.3 Contractor to prepare and distribute copies of meeting minutes.
- 2.4 Coordinate and organize attendance of individual Subcontractors and 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.
- 2.5 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.
- 2.6 Consultant will arrange attendance of other interested parties not responsible to the Contractor.
- 2.7 Inform the Consultant in advance of meetings regarding all items to be added to the agenda.
- 2.8 Be prepared to provide specific information relative to agenda items at each meeting as they are pertinent to the Contract.
- 2.9 Contractor's representative will chair the meeting and record and distribute the minutes within 5 Working Days of meeting date.
- 2.10 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 Work progress since previous meeting.

- .4 Field observations, including any problems, difficulties, or concerns.
- .5 Construction progress schedule.
- .6 Submittal schedule and status of submittals.
- .7 Quality control.
- .8 Coordination.
- .9 Contract Schedule.
- .10 Work plan up to next scheduled meeting.
- .11 Requests for information/clarification.
- .12 Proposed changes in the Work.
- .13 Other business.

3 MEETINGS WITH OTHER CONTRACTORS

- 3.1 Consultant will arrange and organize coordination meetings with Other Contractors working on the Project.
- 3.2 Attend all such meetings and ensure that representative has required authority to commit Contractor to actions agreed upon.
- 3.3 Consultant will document and distribute minutes to participants.

END OF SECTION

1 GENERAL

- 1.1 Be responsible for planning and scheduling the Construction Progress Documentation of the Work.
- 1.2 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.

2 SCHEDULE MANAGEMENT

- 2.1 A schedule submitted as specified and accepted by Consultant shall become the baseline schedule and shall be used as the baseline for updates.
- 2.2 At each regular progress meeting, review and discuss current construction progress and submittals schedules with Consultant, including activities that are behind schedule and planned measures to regain schedule slippage in key areas on or near the critical path.
- 2.3 Activities considered behind schedule are those with start or completion dates later than the dates shown on the baseline schedule.

3 CASH FLOW CHART

- 3.1 Within 7 days after award of Contract, submit, in form approved by Consultant, cash flow chart broken down on a monthly basis in an approved manner. Cash flow chart shall indicate anticipated Contractor's monthly progress billings from commencement of work until completion.
- 3.2 Update cash flow chart whenever changes occur to scheduling and in manner and at times satisfactory to Consultant.

4 CONTRACT SCHEDULE

- 4.1 Prepare and submit, in a format acceptable to the Owner, the Contract Schedule within 10 Working Days following award of Contract. This schedule, once it is reviewed by the Consultant and Owner and if it meets the project requirements, will form part of the Contract.
- 4.2 Contract Schedule shall be developed using a logic network technique for planning and scheduling.
- 4.3 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.

- 4.4 Contract Schedule shall include but not be limited to the following information. Information to be provided in a sufficient level of detail to effectively manage the construction process.
- .1 Starting and ending dates, milestones, and key activities of each activity including the float periods.
 - .2 Work Packages.
 - .3 Manpower requirements for each activity.
 - .4 Order and delivery dates for long delivery Products and major or critical equipment.
 - .5 Interdependency with activities of other Contractors.
 - .6 Dates specified in the Contract Documents.
 - .7 Milestone date[s] for Ready-for-Takeover and Substantial Performance of the Work.
 - .8 Inspection and testing activities.
 - .9 Dates on which specific data will be required for submittal, i.e., Vendor data, shop drawings, samples, etc.
 - .10 Preparation and review of Mock-ups.
 - .11 Shutdown or closure activities.
 - .12 Demonstration and training activities.
- 4.5 Submit updated schedule to the Consultant and Owner monthly indicating as a minimum actual and projected start and finish dates, report date line and progress, activity relationships, float, Contract changes as well as major changes to the schedule.

5 DETAILED CONSTRUCTION SCHEDULE

- 5.1 Prepare and submit a detailed construction schedule within 10 Working Days of final review and acceptance of the Contract Schedule. This schedule, once reviewed and accepted by the Consultant, will be updated and submitted monthly with the Contract Schedule and weekly once the Contractor starts on Site.
- 5.2 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.
- 5.3 The detailed construction schedule shall be presented in a bar chart form.

- 5.4 Include a written report with each updated progress schedule. Indicate work status to date comparing baseline to actual progress, current forecasts, identifying problem areas, anticipated delays and impact on schedule, and planned corrective actions.

6 SUBMITTALS SCHEDULE

6.1 Format and Content:

- .1 Prepare schedule identifying all required Shop Drawing, Product data, and sample submissions, including samples required for testing.
- .2 Prepare schedule in electronic format acceptable to Owner.
- .3 Provide a separate line for each required submittal, organized by Specification section names and numbers, and further broken down by individual Products and systems as required.
- .4 Allow time in schedule for review of submittals and resubmission of submittals, should resubmission be necessary.

6.2 Submission:

- .1 Submit initial schedule to Consultant within 15 Working Days after Contract award.
- .2 Submit schedule in format acceptable to Owner.
- .3 Consultant will review format and content of initial schedule and request necessary changes, if any, within 10 Working Days after receipt.
- .4 If changes are required, resubmit finalized schedule within 5 Working Days after return of review copy.
- .5 Submit updated submittals schedule monthly to Owner and Consultant.

7 PROGRESS RECORDS

- 7.1 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.
- 7.2 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.

8 RECORDING ACTUAL SITE CONDITIONS ON AS-BUILT DRAWINGS

- 8.1 Obtain from Consultant an electronic copy of the construction Drawings for the purpose of creating as-built drawings. Record information in electronic form, clearly identifying as-built deviations from the originally obtained construction Drawings.
- 8.2 CAD drawings of Contract Drawings can be obtained from Consultant at a cost of \$50.00 plus HST per drawing.
- 8.3 Clearly label each drawing as "AS-BUILT DRAWING prepared by _____ (name of Contractor)". Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- 8.4 Authorized deviations from drawings shall be marked in red accurately on one set of drawing prints in a neat, legibly printed manner and shall be dated. Prior to final inspection, neatly transfer the recorded information to a second set of drawing prints of the most recent revision to the drawings and submit both sets to the Consultant.
- 8.5 Maintain as-built drawings up to date as Work progresses. Status of maintained as-built drawings may be considered as a condition for validation of applications for payment. Make as-built drawings available to the Consultant at all times.
- 8.6 Record actual construction including but not limited to the following:
- .1 Accurate dimensioned record of deviations and changes in Work from drawings.
 - .2 Measured depths of elements of foundation in relation to finish first floor datum.
 - .3 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .4 Measured locations of pipes, ducts, conduits, outlets, fixtures, access panels, and appurtenances, referenced to visible and accessible features of construction.
 - .5 Field changes of dimension and detail.
 - .6 Changes made by Change Orders and Supplemental Instructions
 - .7 References to Shop Drawings, where Shop Drawings show more detail.
 - .8 Do not use as-built drawings for construction purposes.
- 8.7 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.

- 8.8 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.
- 8.9 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.
- 8.10 Accurately record any components which will be in inaccessible locations for Consultant's review before the component is covered, or buried, or made inaccessible.
- 8.11 As-built drawings shall be signed and dated by Contractor.
- 8.12 Submit as-built drawing to Consultant for review and make corrections as directed by Consultant.

9 PROGRESS PHOTOGRAPHS

- 9.1 Concurrently with monthly application for payment submit 2 CD's or DVD's of digital pictures in high definition, in format acceptable to Owner, illustrating the progress of the Work as follows:
- .1 A minimum of 20 pictures that best illustrate the progress on the site.
 - .2 Pictures shall be in focus and properly illuminated; view shall be unobstructed.
 - .3 Pictures shall be taken with a minimum 10 megapixel camera or better such that quality and details can be discerned from photo.
 - .4 Pictures shall either have an accurate date-stamp present in the photo, or be numbered and dated in the digital filename.
 - .5 The CD or DVD containing the photo's shall be labeled with the following information: The project name, date taken, the period the pictures are taken in, name of photographer, description of view and date of photograph taken, and the monthly application number which the pictures are associated with.
- 9.2 Do not use progress or any other Project photographs for promotional purposes without Owner's written consent.

10 PROGRESS REPORTS

- 10.1 Prepare a monthly progress report current to the last Friday of each month. The report shall indicate the period covered and include but not be limited to the following:
- .1 Executive Summary.
 - .2 Areas of Concern/Action Required.

.3 Work Accomplished This Period.

.4 Work Planned Next Period.

.5 Schedule Status.

.6 Budget Status.

.7 Status of Submittals.

.8 Quality Control.

.9 Contract Changes.

.10 Outstanding Actions.

10.2 Submit the monthly progress report such that it is received by the Consultant no later than the Wednesday following the last Friday of the month, regardless of whether or not the Monday is a public holiday.

11 PROGRESS VIDEO AND VIEWING

11.1 Provide internet-capable camera and an active web site, allowing off-site viewing of Place of the Work 24/7. Submit web site address and security access codes to Owner and Consultant.

END OF SECTION

1 GENERAL

- 1.1 Provide labour, Products, equipment, services tools and supervision necessary for submittals work.
- 1.2 Submit electronic copies of submittals in a format acceptable to Owner where submittals are specified in technical Specifications.
- 1.3 Submit submittals to Consultant for review. Submit with reasonable promptness and in orderly sequence so as to not cause delay in the Work. Failure to submit in ample time is not considered sufficient reason for an extension of Contract Time or for Product substitutions or other deviations from the Drawings and Specifications.
- 1.4 Verify accuracy and completeness of submittals prior to submission.
- 1.5 Verify field measurements, field construction criteria, catalogue numbers and similar data.
- 1.6 Coordinate each submittal with requirements of the Work and the Contract Documents.
- 1.7 Where required by authorities having jurisdiction, provide submittals to such authorities for review and approval.
- 1.8 Do not proceed with Work affected by a submittal until review is complete.
- 1.9 Present Shop Drawings, Product data, and samples in SI metric units. Where items or information is not produced in SI metric units [imperial], converted values are acceptable.
- 1.10 Supplement standard information to include details applicable to Project.
- 1.11 Review submittals and affix Contractor's review stamp prior to submission to Consultant. Contractor's review stamp represents that necessary requirements have been determined and verified, and that the submittal has been checked and coordinated with requirements of the Work and Contract Documents.
- 1.12 Submittals not meeting specified requirements will be returned with comments.
- 1.13 Reproduction of construction Drawings to serve as background for Shop Drawings is not permitted without written permission of Consultant.
- 1.14 Do not propose Substitutions or deviations from Contract Documents via Shop Drawing, Product data and sample submittals.
- 1.15 Notify Consultant in writing at time of submission, of any deviation in submittals from requirements of the Contract Documents.

- 1.16 Submit in accordance with dates established under Section 01 32 00 for shop drawings, fabrication, manufacture, erection and installation to provide adequate time for reviews, securing necessary approvals, possible revisions and resubmittals, placing orders, securing delivery and to avoid construction delays.
- 1.17 Accompany each submittal with a letter of transmittal in duplicate containing all pertinent information required for identification and checking of submittals including but not limited to the following:
 - .1 Date of initial submission and date of each subsequent submission if required.
 - .2 Project title and Consultant's project number.
 - .3 Names and address of:
 - .1 Contractor.
 - .2 Subcontractor.
 - .3 Supplier/manufacturer/fabricator as applicable.
 - .4 Identification of each submittal item and quantity.
 - .5 Specification section numbers to which submission is related.
 - .6 Countersigned stamp of Contractor certifying that they have reviewed the submission.
- 1.18 Allow 10 Working Days for Consultant's review of each submittal and incorporate in submittals schedule specified in Section 01 32 00. Allow additional 5 Working Days where sub-Consultant review is required.
- 1.19 When submittals are resubmitted, transmit under a new letter of transmission.
- 1.20 Where a submittal includes information not applicable to the Work, clearly identify applicable information and strike out non-applicable information.
- 1.21 If upon Consultant's review no errors or omissions are discovered, or if only minor corrections are required as indicated, submittal will be returned and fabrication or installation of Work may proceed.
- 1.22 If upon Consultant's review significant errors or omissions are discovered, a so noted copy will be returned for correction and resubmission. Do not commence fabrication or installation.
- 1.23 Consultant's notations on submittals are intended to ensure compliance with Contract Documents and are not intended to constitute a change in the Work requiring change to the Contract Price or Contract Time.
- 1.24 Resubmit corrected submittals through same procedure indicated above, before any fabrication or installation of the Work proceeds. When resubmitting, notify Consultant in writing of any revisions other than those requested by Consultant.

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- 1.25 Do not carry out Work until Consultants review of submittals has been completed.
- 1.26 Be responsible for payment of charges for delivery of submissions and resubmission to Consultant.
- 2 SHOP DRAWINGS AND PRODUCT DATA**
- 2.1 The term "Shop Drawings" means drawings, diagrams, schematics, illustrations, schedules, performance charts, product data, brochures and other data which are required to illustrate details of the Work.
- 2.2 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.
- 2.3 In addition to Shop Drawings specified in the specification sections, submit Shop Drawings required by jurisdictional authorities in accordance with their requirements.
- 2.4 Shop Drawings for openings, sleeving and conduit:
- .1 Prior to preparation of Shop Drawings, coordinate sizes of all structural openings and sleeves with respective fabricators for mechanical ducting. Adjustments to the opening sizes indicated on the Contract Drawings shall not be made without the approval of the Consultant.
 - .2 Prior to detailing structural reinforcement on Shop Drawings, arrange for the Structural Engineer to review formed holes, recesses and sleeving. Completely dimension openings, recesses and sleeves and relate to appropriate grid line(s) and elevation(s).
 - .3 Prior to forming of the structure, arrange for the preparation of Shop Drawings for review by the Consultant showing embedded conduit to be cast within the structure. Shop Drawings shall include conduit from all sources.
- 2.5 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 Indicate Products, methods of construction, and attachment or anchorage, fabrication and erection diagrams, dimensions, connections, explanatory notes and other information necessary for completion of the Work.
 - .3 Provisions for allowable construction tolerances and deflections provided for live loading.

- .4 Where Products attach or connect to other Products, indicate construction arrangements and details of the parts and their connections, and interconnections with other work and that such items have been coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross-references to Drawings, Specifications and other already reviewed Shop Drawings.
 - .5 Location and type of anchors and exposed fastenings.
 - .6 Materials, physical dimensions including thicknesses, and finishes.
 - .7 Descriptive names of equipment.
 - .8 Mechanical and electrical characteristics when applicable.
 - .9 Information to verify that superimposed loads will not affect function, appearance, and safety of the work detailed as well as of interconnection work.
 - .10 Assumed design loadings, and dimensions and material specifications for load-bearing members.
- 2.6 Include in Shop Drawing submissions detailed information, templates, and installation instructions required for incorporation and connection of the Work.
- 2.7 Ensure shop drawings are of one uniform size and based on field measurements.
- 2.8 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. Contractor's review of each Shop Drawing shall be indicated by stamp, date and signature of a qualified person possessing the appropriate authorization from the Contractor.
- 2.9 Be responsible for dimensions, confirmed 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.
- 2.10 Submit Shop Drawings for the Consultant's review with reasonable promptness and in orderly sequence so as 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.
- 2.11 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.

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- 2.12 Submit Shop Drawings signed and sealed by a licensed Professional Engineer registered in the place of the Work where indicated in individual Sections.
- 2.13 Shop Drawings shall have distinct, uniform letters, numerals and line thicknesses that will ensure the production of clear legible prints at original as well as reduced size.
- 2.14 Shop Drawing submissions shall be made as follows:
- .1 In all instances where practical, submit Shop Drawings in electronic Portable Document Format (PDF) format delivered via the web-based Rform Contract Administration software to the Consultant in accordance with Consultant's directions.
 - .2 Where impractical to provide electronic PDF submissions, provide two (2) hard copy prints of each sheet, folded into letter size (216 mm x 280 mm) with title block appearing on the outside.
- 2.15 Shop Drawings shall include the following minimum information:
- .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, date, and signature of Contractor's authorized representative responsible for Shop Drawing review, indicating that each Shop Drawing has been reviewed for compliance with Contract Documents and, where applicable, that field measurements have been verified.
 - .5 Details of appropriate portions of the Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.
 - .5 Performance characteristics.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.
 - .10 Relationships to other parts of the Work.
 - .6 On submissions subsequent to the first, the following additional identification:
 - .1 The revised submission number.
 - .2 Identification of the item(s) revised.
- 2.16 Dimensions and designations of elements shall be shown in the same system of measurement used on the applicable Contract Drawings.
- 2.17 Consultant reserves the right to refuse acceptance of drawing submissions not meeting the above requirements.

2.18 Consultant's review will be for conformity to the design concept and for general arrangement only and such review shall not relieve the Contractor of responsibility for errors or omissions in the Shop Drawings or of responsibility for meeting all requirements of the Contract Documents 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.

2.19 Only drawings noted for revision and resubmission need be resubmitted.

2.20 File one copy of each submitted Shop Drawing at the Site.

2.21 Product Data:

- .1 Before delivery of Products to the Site, submit of Product data as specified in each section or as requested by the Consultant.
- .2 Product data submittals shall include material safety data sheets (MSDS) for all controlled Products.
- .3 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/specified standards.

3 SAMPLES

3.1 Before delivery of Products to the Site, submit duplicate 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.

3.2 Deliver samples prepaid to Consultant's business address unless another mutually agreed to location is established.

3.3 Identify samples with Project name, Contract number, date, Contractor's name, number and description.

3.4 Where a required colour, pattern or texture has not been specified, submit full range of available Products meeting other specified requirements.

3.5 Ensure samples are of sufficient size and quantity, if not already specified, to illustrate:

- .1 The quality and functional characteristics of Products, including integrally related parts and attachment devices.

- .2 The full range of colours available.
- 3.6 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.
- 3.7 Consultant selection from samples is not intended to change the Contract Price or Contract Time. If a selection would affect the Contract Price or Contract Time, notify Consultant in writing prior to proceeding with the Work.
- 3.8 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.
- 3.9 Resubmit samples as required by Consultant to comply with Contract Documents.
- 3.10 Reviewed and acceptable samples will establish the standard against which installed Work will be reviewed.
- 3.11 Each Product incorporated in the Work shall be precisely the same in all details as the acceptable sample.
- 3.12 Should there be any change to the accepted sample, submit in writing for approval of the revised characteristics and resubmit samples of the Product for approval if requested.
- 3.13 When samples are very large, require assembly, or require evaluation at the Site, they may only be delivered to the Site with approval and as directed.

4 CERTIFICATES

- 4.1 Submit certificates that are required by authorities having jurisdiction or that are requested in the applicable specification sections.
- 4.2 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.
- 4.3 Certificates shall verify that Products and/or methods meet the specified requirements and shall include test reports of testing laboratories approved to validate certificates.
- 4.4 Submit certificates in duplicate and signed by an authorized representative of the certifying company.

5 CERTIFICATION OF TRADESMEN

- 5.1 Provide certificates, at the request of the Consultant, to establish qualifications of personnel employed on the Work where such certification is required by authorities having jurisdiction, by the Consultant or by the Contract Documents.

6 EXTENDED WARRANTIES

6.1 Submit extended warranties as requested in sections of the Specifications showing title and address of Contract, warranty commencement date and duration of warranty.

6.2 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.

6.3 Submit each extended warranty on a form that is acceptable to the Owner and Consultant.

7 INSPECTION AND TEST REPORTS

7.1 Submit inspection and test reports as specified in the Sections of the specifications for "Source Quality Control" and "Field Quality Control" within 5 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.

7.2 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.

7.3 Inspection and test reports shall be signed by a responsible officer of the inspection and testing company.

8 RECORD DOCUMENTS

8.1 Submit record documents in accordance with Section 01 78 00.

END OF SECTION

1 CONSTRUCTOR

- 1.1 For the purposes of the Contract, the term "Constructor", as defined in the Occupational Health and Safety Act, shall mean the Contractor who shall be responsible for ensuring that the provisions of the statutes, regulations and by-laws pertaining to the safe performance of the Work are to be observed. The "Constructor" shall submit the Notice of Project.
- 1.2 In the event of conflict between any of the provisions of Statutes, Regulations and By-laws, and other requirements of authorities, the most stringent provision applies.
- 1.3 The Contractor's representative shall be responsible for ensuring that the provisions of statutes, regulations and by-laws pertaining to safe performance of the Work and the work of Other Contractors and Owner's own forces working on the Site are observed and that the methods of performing the Work do not endanger the personnel employed thereon nor the general public, and are in accordance with the latest edition of the Occupational Health and Safety Act. Include on the Joint Health and Safety Committee representatives of Other Contractors working on Site.
- 1.4 Prior to the Contractor's representative being absent from the Site for an extended period during execution of the Work, the Contractor's representative will name, in writing to the Consultant, another person who is competent to assume these responsibilities. The Contractor shall advise the Consultant of change of the individual identified as the Contractor's representative.
- 1.5 At the discretion of the Consultant, the "Constructor" designation may be transferred to/from a Contractor at any time at no additional cost to the Owner.

2 PROJECT RESPONSIBILITIES

- 2.1 The Contractor's representative shall ensure that:
- 2.2 All measures and procedures prescribed by the following Acts and Regulations are carried out on Site:
- .1 The Occupational Health and Safety Act;
 - .2 The Regulations for Construction Projects;
 - .3 WHMIS Regulations;
 - .4 The Environmental Protection Act and regulations,
 - .5 All other legislation, regulations and standards as applicable.
- 2.3 Every employer and every worker performing Work on the Site must comply with the requirements referred to above.

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- 2.4 Ensure that the health and safety of workers, employees of the Owner and the general public are protected in relation to the Work performed on the Site.
- 3 **WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS)**
- 3.1 Be familiar with and comply with WHMIS regulations.
- 3.2 Properly label controlled products. Provide proper warning labels and training at the Site.
- 3.3 Maintain on site for duration of Contract a hazardous materials log containing all required SDS. Log shall be open for inspection by Owner, Consultant and all personnel on Site.
- 3.4 Provide copies of safety data sheets (SDS) for any controlled products prior to delivery to the Site.
- 3.5 Be responsible for all applicable requirements of the regulations.
- 3.6 Before commencing any Work on Site, attend the pre-construction meeting and provide the Consultant with a proposal as to how hazardous materials will be stored and dispensed on Site. In addition, specifically outline the measures which will be undertaken to prevent damage or injury in the event of an accidental spill.
- 3.7 Provide "Handling Procedure for Hazardous Materials".
- 4 **JOINT HEALTH AND SAFETY COMMITTEE**
- 4.1 The Contractor shall be responsible for the establishment and operation of the Joint Health and Safety Committee as required by the Occupational Health and Safety Act.
- 5 **DELIVERABLES**
- 5.1 The Contractor shall deliver to the Consultant:
- .1 The Contractor's Occupational Health and Safety Policy.
 - .2 The Contractor's safety program to implement the Occupational Health and Safety Policy for the Contract, which will effectively prevent and control accidents for the Contract.
 - .3 A copy of all communications with, and including all orders by, the Ministry of Labour or other occupational health and safety enforcement authority.
 - .4 A copy of all accident/injury investigation reports, not just the WSIB Form 7. Each report must contain a statement of actions that will be taken to prevent a recurrence.

- .5 A copy of all inspection reports made by the Contractor in compliance with the employer's responsibility under the Occupational Health and Safety Act.
- .6 A copy of all safety information pertaining to the Contract made and furnished by the Contractor's own "Safety Personnel" or outside consultants/advisers engaged for the purpose of inspecting the workplace for occupational health and safety.
- .7 A verification that all workers in the employ of the Contractor on Site, have had a WHMIS training or refresher course within the last twelve months.
- .8 A verification that all workers in the employ of the Contractor have had "Explosive Activated Tool Training" on the type of tools being used.
- .9 A verification that the instruction manuals are on Site for all tools and equipment being used.
- .10 A copy of the most recent workers compensation experience rating account, i.e. CAD-7, NEER, and/or an insurance carrier's experience rating account.
- .11 Statistical information for the purpose of determining injury frequency and severity rates (hours worked, first-aid injuries, medical aid injuries, lost time injuries, restricted workday injuries, near-miss accident/incident and significant occurrence data), in a timely manner as required by the Consultant.
- .12 The immediate reporting to the Consultant of all instances that are defined in the Occupational Health and Safety Act as "Notices of Injuries" and "Occurrences" and any occasion that a worker exercises their "Right to Refuse Unsafe Work".
- 5.2 The Consultant reserves the right to require additional or amended deliverables pertaining to safety during the duration of the Work at no additional cost to the Owner.
- 5.3 Items specified above shall be delivered to the Consultant prior to the Contractor commencing Work on the Site.
- 6 **DUE DILIGENCE**
 - 6.1 The Contractor acknowledges that it has read and understands the measures and procedures relating to occupational health and safety as prescribed above. The Contractor acknowledges and understands its duties as therein set out and hereby expressly undertakes and agrees to comply with all such requirements and standards in their entirety and at the Contractor's expense.
 - 6.2 The Contractor further agrees to fully cooperate with all health and safety requirements, rules, regulations, standards and criteria set out in the Contract Documents, which agreement is in furtherance of the Contractor's duties and responsibilities under occupational health and safety legislation.

- 6.3 The Contractor agrees that if, in the opinion of the Consultant or Owner, the health and safety of a person or persons is endangered or the effective operation of the system put in place to ensure the health and safety of workers on the Site is not being implemented, the Consultant or Owner may take such action as it deems necessary and appropriate in the circumstances, including, without limitation, the following:
- .1 Require the Contractor to remedy the condition forthwith at its own expense;
 - .2 Require that the Site be shut down in whole or in part until such time as the condition has been remedied;
 - .3 Remedy the problem and the Owner shall back-charge the Contractor for the cost of such remedial work, together with an appropriate overhead factor as determined by the Owner in its sole discretion; and
 - .4 Terminate the Contract without further liability in the event the Contractor fails to comply with these provisions.
- 6.4 If a lien is registered, in respect to any monies held back, back-charged or assessed in accordance with these paragraphs, the Contractor shall consent to an order vacating such registration and shall indemnify the Owner for any and all loss, whereby direct or consequential which the Owner may sustain as a consequence of such registration.
- 7 **SITE SAFETY PERSONNEL**
- 7.1 In the event the Consultant deems it necessary, because of the Work, the Contractor shall assign a "Competent Safety Person" to assist the Contractor's representative in the discharging of safety responsibility, at no additional cost to the Owner.

END OF SECTION

1 GENERAL

- 1.1 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.
- 1.2 Employment of inspection and testing agencies by Contractor or Owner does not relieve Contractor from responsibility to perform the Work in accordance with Contract Documents.
- 1.3 Allow and arrange for inspection and testing agencies to have access to the Work, including access to off site manufacturing and fabrication plants.
- 1.4 Verify by certification that specified products meet the requirements of reference standards specified in the applicable specification sections.
- 1.5 Conduct testing, balancing and adjusting of equipment and systems specified in applicable mechanical and electrical specifications sections by independent testing company.

2 INSPECTION AND TESTING BY OWNER

- 2.1 The Owner may inspect and test Products during manufacture, fabrication, shop testing, installation, construction and testing phases of the Contract. The Consultant will ascertain the quantity and quality of testing to be performed. Inspection and testing may be performed at the place of manufacture/fabrication, storage, or at the Site as designated by the Consultant. Where inspection and testing is done either during manufacture, fabrication, or at Site, ensure that proper facilities and assistance are provided.
- 2.2 Owner retained inspection and testing:
 - .1 The Consultant, on behalf of the Owner may appoint an independent inspection and testing company to carry out quality control reviews of parts of the Work for conformance to the Contract Documents.
 - .2 Such costs for inspection and testing will be paid by the Owner. However, any additional inspection and testing due to non-conformance to the Contract Documents shall be at the Contractor's expense.
- 2.3 Inspection and testing under allowances:
 - .1 Submit a list of inspection and testing agencies for approval by the Owner and Consultant. Inspection and testing services will be tendered by the Contractor and the results submitted to the Consultant for review and approval.

- .2 Such costs for inspection and testing will be paid by the Cash Allowance. However, any additional inspection and testing due to non-conformance to the Contract Documents shall be at the Contractor's expense. Cash allowance excludes any inspection and testing that is for Contractor's own quality control or is required by regulatory requirements.

- 2.4 Inspections and testing by the independent inspection and testing company will be promptly made. Uncover for examination any Work covered up prior to inspection or without approval of the Consultant. Make good such Work at no cost to the Owner.

3 **INSPECTION AND TESTING BY CONTRACTOR**

- 3.1 Retain and pay for inspection and testing required for Contractor's own quality control, by regulatory requirements, to ensure performance of the work or where identified in the Contract Documents.

- 3.2 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 Contractor's own inspection and testing quality control shall not include responsibilities and procedures that relate solely to an inspection and testing company's functions that are retained directly by the Owner or paid for under a cash allowance. Such information is included in this Section for Contractor's information only.

- 3.3 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.

4 **QUALIFICATIONS OF INSPECTION AND TESTING COMPANIES**

- 4.1 Inspection and testing companies to be certified by the Standards Council of Canada (SCC) or Canadian Council of Independent Laboratories (CCIL).

- 4.2 Companies engaged for inspection and testing shall provide equipment, methods of recoding and evaluation, and knowledgeable personnel to conduct tests precisely as specified in reference standards.

- 4.3 If requested, submit affidavits and copies of certificates of calibration made by an accredited calibrator to verify that testing equipment was calibrated and its accuracy ensured within the previous twelve months.

5 RESPONSIBILITIES OF INSPECTION AND TESTING COMPANIES

- 5.1 Determine from specifications and Drawings the extent of inspection and testing required for Work of the Contract. Subcontractors shall notify Consultant of any omissions or discrepancies in the work inspected and/or tested.
- 5.2 Perform applicable inspection and testing described in the Specifications and as may be additionally directed.
- 5.3 Provide competent inspection and testing personnel when notified by the Contractor that applicable work is proceeding. Inspection personnel shall cooperate with the Consultant and Contractor to expedite the Work.
- 5.4 Subcontractors shall notify the Consultant and Contractor of deficiencies and irregularities in the Work immediately when they are observed in the course of inspection and testing.
- 5.5 Inspection and testing companies shall not perform or supervise any of the Contractor's work, and shall not authorize:
 - .1 Performance of work that is not in strict accordance with the Contract Documents.
 - .2 Approval or acceptance of any part of the Work.

6 INSPECTION AND TESTING PROCEDURES

- 6.1 Perform specified inspection and testing only in accordance with specified Reference standards, or as otherwise approved.
- 6.2 Observe and report on compliance of the Work to requirements of Contract Documents.
- 6.3 Ensure that inspectors are on site or at fabricator's operations for full duration of critical operations, and as otherwise required to determine that the Work is being performed in accordance with the contract Documents.
- 6.4 Submit test samples required for testing in accordance with submittals schedule specified in Section 01 32 00.
- 6.5 Provide labour, Construction Equipment and temporary facilities to obtain and handle test samples on site.
- 6.6 Identify samples and sources of materials.
- 6.7 Review and report on progress of the work. Report on count of units fabricated and inspected at fabricator's operations.
- 6.8 Observe and report on conditions of significance to work in progress at time of inspection or at fabricator's operations. Include where applicable and if critical to the work in progress:

- .1 Time and date of inspection.
- .2 Temperature of air, materials, and adjacent surfaces.
- .3 Humidity of air, and moisture content of materials and adjacent materials.
- .4 Presence of sunlight, wind, rain, snow and other weather conditions.

6.9 Ensure that only materials from the work and intended for use therein are tested.

6.10 Determine locations for work to be tested.

7 INSPECTION AND TESTING REPORTS

7.1 For inspection and testing required by Contract Documents or by regulatory requirements, and performed by Contractor retained inspection and testing agencies, submit to Consultant and Owner copies of reports. Submit within 5 Working days after completion of inspection and testing.

7.2 For inspection and testing performed by Owner retained inspection and testing agencies, copies of inspection and testing agency reports will be provided to Contractor.

7.3 Include in reports all information critical to inspection and testing.

8 TOLERANCES FOR INSTALLATION OF WORK

8.1 Unless specifically indicated otherwise, work shall be installed plumb, level, square and straight.

8.2 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 in excess of 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 0.5 mm for other interior surfaces.

8.3 Allowable tolerances shall not be cumulative.

9 **REFERENCE STANDARDS**

- 9.1 Perform inspection and testing in accordance with Standards quoted and as required by procedures described in specified reference standards that are applicable to the work being inspected and tested.

10 **DEFECTS AND REMEDIAL WORK**

- 10.1 Defective products, materials and workmanship found at any time prior to Ready-for-Takeover 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.
- 10.2 Notify Consultant of, and perform remedial work required to, repair or replace defective or unacceptable work. Ensure that properly qualified workers perform remedial work. Coordinate adjacent affected work as required.

11 **SAMPLE UNITS**

- 11.1 Sample units will be established at a later date by Consultant. Sample units shall include the room proper, including their washrooms and including the full width and length of corridors adjoining these rooms.
- 11.2 Sample unit preparation shall proceed in two stages:
- .1 Stage 1: partitions framed and all services roughed-in; potential interferences shall be identified and access to isolation valves and fire dampers shall be shown.
- .2 Stage 2: complete in all respects including finishes, fixtures, fitments, cabinets, appliances, hardware and trim, with all services fully energized and operational, cleaned and ready for use.
- 11.3 Work in sample units shall be complete, reviewed and accepted prior to executing work in other units.
- 11.4 Upon completion of each stage and after being notified by Contractor, Consultant will inspect units and if necessary prepare and issue a list of deficiencies.
- 11.5 Contractor shall correct deficiencies as directed by Consultant, until units meet requirements of Contract Documents.
- 11.6 Sample units, once accepted by Consultant, shall serve to establish a minimum standard for all other units.

12 **MOCK UPS**

- 12.1 Prepare mock-ups of Work as specified in the technical Specifications. If a mock-up location is not indicated in the Drawings or Specifications, locate where directed by Consultant. Construct mock-ups of Work as required by Contract Documents on site unless otherwise indicated herein or directed by Consultant.
- 12.2 Construct mock-ups prior to start of affected work. Allow sufficient time for Consultant's review. Work affected by mock-ups may not commence prior to acceptance of mock-ups.
- 12.3 Construct mock-ups to include all related specified materials and workmanship. Make revisions as directed by Consultant, in accordance with the intent of the Contract Documents, until mock-ups are acceptable.
- 12.4 Modify mock-up as required until Consultant approval is obtained.
- 12.5 Mock-ups, reviewed and accepted by Consultant, shall become the standard of quality against which installed work will be measured.
- 12.6 Protect mock-ups from damage until the Work they represent is complete.
- 12.7 Mock-ups, by prior arrangement, may be incorporated into finished work if approved by Consultant only.
- 12.8 Remove mock-ups only when the Work they represent is complete or when otherwise directed by Consultant.

13 **EXTERIOR WALL MOCK-UP**

- 13.1 For exterior wall elements, construct a 10 m² mock-up of wall system incorporating all wall components specified. Construct mock-up on Site in a location acceptable to Consultant.
- 13.2 The mock-up shall include the work of all trades involved in exterior wall elements, complete in all respects including masonry, air/vapour retarders, wall cladding, aluminum work, sealants, etc., and shall establish a minimum standard for the work of the exterior wall elements, clear up any misunderstandings and point out any possible problems.
- 13.3 Upon completion of mock-up, and after being notified by the Contractor, Consultant will inspect mock-up and if necessary prepare and issue a list of deficiencies. Once mock-up has been accepted, it will form the minimum standard of quality for exterior wall elements.
- 13.4 Mock-up will not form part of the work and will be independent of building. Remove and dispose of mock-up from Site during final cleanup, or when directed by Consultant.

14 **BUILDING ENVELOPE**

- 14.1 Requirements specified herein apply to all elements of the exterior building envelope.
- 14.2 Continuity of air barrier/vapour retarder and insulation components is critical and must be maintained at all locations. Where different systems meet, ensure proper interface and continuity between adjacent components by implementing suitable construction sequences and by using compatible materials only.
- 14.3 Maximum air leakage shall be $0.10 \text{ L}/(\text{s}\cdot\text{m}^2)$ when measured with a warm-side relative humidity of 27-55% at 21°C and a measured air pressure difference of 75Pa.
- 14.4 Anchor exterior cladding components to structure in manner suitable to accommodate structural deflection and creep and to withstand loads from expected temperature gradients. Design anchorage to withstand expected wind loads, positive and negative, in accordance with applicable regulations.
- 14.5 Ensure that air spaces within exterior building components are firestopped in accordance with applicable regulations.
- 14.6 Ensure that air spaces on the outside of vertical air barrier/vapour retarder (walls), window systems, and curtain wall systems are constructed with adequate drainage provisions to the exterior.
- 14.7 Owner may complete a thermographic scan upon completion of the building envelope. Contractor will be responsible to correct identified thermal anomalies.

15 **DRAINAGE**

- 15.1 Layout and construct work to ensure that positive drainage is provided to floor drains, ditches, site drains and catch basins, as set in their final position, preventing undrained areas and ponding.
- 15.2 Ensure that allowable construction tolerances and structural deflection do not cause ponding of water.
- 15.3 Report to Consultant in writing prior to executing work affected, in case adequate drainage cannot be provided.

END OF SECTION

1 GENERAL

- 1.1 Provide Labour, Products, equipment, services, tools and Supervision to ensure that Work complies with minimum acceptable standards of materials and performance of Work in accordance with codes and standards referenced in the Specification.
- 1.2 Consider contract forms, codes, Specifications, standards, manuals, and installation and application instructions referred to in these specifications to be the latest published editions at the date of submission of the bid unless otherwise stated in the Specifications or otherwise required by the authorities having jurisdiction.

2 BY-LAWS, PERMITS, AND FEES

- 2.1 Comply with all By-Laws and regulations of authorities having jurisdiction. These codes and regulations constitute an integral part of the Contract Documents.
- 2.2 Owner shall apply and pay for Municipal Building Permit, and Contractor shall obtain and pay for all other permits, licenses, deposits, and certificates of inspection as part of the Contract Price as per Conditions of the Contract. Ensure that permits, licenses, deposits, and certificates included under specific Sections are provided as specified.
- 2.3 If required, pay for construction damage deposit required by authorities having jurisdiction.
- 2.4 Where permits, licences, and inspection fees are required by authorities having jurisdiction for specific trade functions, they shall be obtained by particular subtrade responsible for that work.
- 2.5 Arrange for inspection, testing of Work and acceptance required by the authorities having jurisdiction. Be responsible for necessary preparations, provisions and pay all associated costs.
- 2.6 Be responsible for ensuring that no work is undertaken which is conditional on permits, approvals, reviews, licences, fees, until all applicable conditions are met. No time extension will be allowed for delay in obtaining necessary permits.
- 2.7 Any additional work or changes to the materials due to Work not complying with the British Columbia Building Code and Regulations as indicated by the Building Inspector shall be changed. All costs involved shall be borne by Contractor.
- 2.8 Obtain permit required to work on Municipal rights of way. Provide damage deposits for sidewalks, roads and services work, as applicable.
- 2.9 Give notice of completion of project prior to occupancy, as required by applicable legislation.

3 EXISTING PUBLIC SERVICE LINES

- 3.1 Where existing public services are indicated to be removed and/or relocated, perform Work in compliance with authorities having jurisdiction.
- 3.2 Make good public roads, walkways and curbs soiled or damaged due to construction to the requirements of local authorities.

4 CODES

- 4.1 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.
- 4.2 In the event of conflict between documents specified herein, execute the Work in accordance with the most stringent requirements.

5 REFERENCE STANDARDS

- 5.1 "Reference standards" means consensus standards, trade association standards, guides, and other publications expressly referenced in Contract Documents.
- 5.2 Where an edition or version date is not specified, referenced standards shall be deemed to be the latest edition or revision issued by the publisher at the time of bid closing. However if a particular edition or revision date of a specified standard is referenced in an applicable code or other regulatory requirement, the regulatory referenced edition or version shall apply.
- 5.3 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 manufacturer which does meet the requirements of the standard, at no additional cost to the Owner.
- 5.4 Reference standards establish minimum requirements. If Contract Documents call for requirements that differ from a referenced standard, the more stringent requirements shall govern.
- 5.5 If compliance with two or more reference standards is specified and the standards establish different or conflicting requirements, comply with the most stringent requirement. Refer uncertainties to Consultant for clarification.
- 5.6 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.

- 5.7 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.
- 5.8 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.
- 5.9 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.
- 5.10 Within the Specifications, reference may be made to the following standards writing, testing, or certification organizations by their acronyms or abbreviations:

.1	AA	Aluminum Association
.2	AAMA	Architectural Aluminum Manufacturers Association
.3	AASHTO	American Association of State Highway and Transportation Officials
.4	ACI	American Concrete Institute
.5	AFBMA	Anti-Friction Bearing Manufacturer's Association
.6	AIEE	American Institute of Electrical Engineers
.7	AISC	American Institute of Steel Construction
.8	AISI	American Iron and Steel Institute
.9	AMCA	Air Movement and Control Association
.10	AMEU	Association of Municipal Electric Utilities
.11	ANSI	American National Standards Institute
.12	APA	American Plywood Association
.13	ARI	Air-Conditioning and Refrigeration Institute
.14	ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
.15	ASME	American Society of Mechanical Engineers
.16	ASTM	American Society for Testing and Materials
.17	AWMAC	Architectural Woodwork Manufacturers Association of Canada
.18	AWPA	American Wire Producers Association
.19	CaGBC	Canadian Green Building Council
.20	CEMA	Canadian Electrical Manufacturer's Association
.21	CGSB	Canadian General Standards Board
.22	CISC	Canadian Institute of Steel Construction
.23	CMPA	Canadian Paint Manufacturers Association
.24	CPCI	Canadian Prestressed Concrete Institute
.25	CRCA	Canadian Roofing Contractors Association
.26	CSA	Canadian Standards Association
.27	CSSBI	Canadian Sheet Steel Building Institute
.28	CWB	Canadian Welding Bureau
.29	CWC	Canadian Wood Council
.30	EEMAC	Electrical and Electronic Manufacturers Association Canada
.31	FM	Factory Mutual
.32	ICEA	Insulated Cable Engineers Association
.33	IEEE	Institute of Electrical and Electronics Engineers

.34	IGMAC	Insulating Glass Manufacturers Association of Canada
.35	LEED	Leadership in Energy and Environmental Design
.36	MFMA	Maple Flooring Manufacturers Association
.37	MPI	Master Painters Institute
.38	MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
.39	NAAMM	National Association of Architectural Metal Manufacturers
.40	NAAWS	North American Architectural Woodwork Standards
.41	NEMA	National Electrical Manufacturers Association
.42	NFPA	National Fire Protection Association
.43	NHLA	National Hardwood Lumber Association
.44	NLGA	National Lumber Grades Authority
	NRC	National Research Council of Canada
.45	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
.46	SSPC	The Society for Protective Coatings
.47	TTMAC	Terrazzo, Tile and Marble Association of Canada
.48	ULC	Underwriters' Laboratories of Canada

6 FIRE RATINGS, ASSEMBLIES AND SEPARATIONS

6.1 Where a material, component, assembly, or separation 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.

6.2 Where reference is made to only one testing authority an equivalent fire rating as determined or listed by another of the aforementioned 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.

6.3 Fire rated door assemblies shall include doors, frame, anchors, and hardware and shall bear label of fire rating authority showing opening classification and rating.

6.4 Material having a fire hazard classification shall be applied or installed in accordance with fire rating authorities printed instructions.

- 6.5 Fire rated assemblies shall be constructed in accordance with applicable fire test report information issued by fire rating authority. Deviation from fire test report will not be allowed.
- 6.6 Construct fire separations as continuous, uninterrupted elements except for permitted openings. Extend fire rated walls and partitions from floor to underside of structural deck above.
- 6.7 Fire separations may be pierced by openings for electrical and similar service outlets provided such boxes are non-combustible and are tightly fitted and sealed with a ULC approved sealant for the assembly being sealed.
- 6.8 Construction that abuts on or is supported by a non-combustible fire separation shall be constructed so that its collapse under fire conditions will not cause the collapse of the fire separation.
- 6.9 Do not use combustible members, fastenings, attachments and similar items to anchor electrical, mechanical or other fixtures to fire separations.
- 6.10 At penetration through fire rated walls, ceilings or floors, completely seal voids with ULC approved firestopping material; full thickness of the construction element. In locations that require a smoke seal, provide appropriate ULC approved system installed in accordance with the manufacturer's recommendations.

END OF SECTION

1 TEMPORARY CONTROLS AND CONSTRUCTION FACILITIES

- 1.1 Provide temporary controls and construction facilities as necessary for performance of the Work and in compliance with applicable regulatory requirements.
- 1.2 Maintain temporary controls and construction facilities in good condition for the duration of the Work.
- 1.3 Remove controls and temporary construction facilities from Place of the Work when no longer required.

2 TEMPORARY CONTROLS

- 2.1 Hoarding, fencing and barriers:
 - .1 Erect temporary hoarding, fencing and barriers around entire perimeter of Site to height determined by applicable regulatory requirements.
 - .2 Before commencing operations, supply, erect and maintain hoarding as determined by applicable regulatory requirements to protect public and private property from injury or damage. Paint outside of hoarding in a colour selected by the Consultant and mark with "POST NO BILLS" signs.
 - .3 Before commencing operations, supply, erect and maintain chain link as determined by applicable regulatory requirements to protect public and private property from injury or damage.
 - .4 Provide temporary enclosures as required to protect the building in its entirety or in its parts, against the elements, to maintain environmental conditions required for work within the enclosure, and to prevent damage to materials stored within.
 - .5 Provide lockable gates through hoarding, fencing, and barriers for access to Site by workers and vehicles.
- 2.2 Prevent unauthorized entry to the Site. Barricade, guard or lock access points to the satisfaction of the Consultant and post "NO TRESPASSING" signs.
- 2.3 Provide hoarding, barriers and covered walkways required by governing authorities for public safety, public rights-of-way and for access to buildings. Snow fencing is not allowed as protection for sidewalk.
- 2.4 Install signs for movement of people around Work Site as required and directed by the Consultant.
- 2.5 Provide secure, rigid guide rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs as required for protection of Work, workers, and the public.
- 2.6 Remove hoarding, fencing, barriers, building enclosures, guide rails and barricades upon completion of Contract, unless otherwise noted on the Contract Drawings or as directed by the Consultant.

3 WEATHER ENCLOSURES

- 3.1 Provide weather tight enclosures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.
- 3.2 Provide weather enclosures to protect floor areas where walls are not finished and to enclose work areas that require temporary heating.
- 3.3 Design weather enclosures to withstand wind pressure and snow loading requirements.

4 DUST TIGHT SCREENS AND PARTITIONS

- 4.1 Provide dust tight selected partitions to localize interior building areas from dust and noise generating activities.
- 4.2 Erect, maintain, and relocate screens and partitions as required to facilitate construction operations and Owner's operational requirements.

5 SERVICE AND UTILITY SYSTEMS

- 5.1 Consult with utility companies and other authorities having jurisdiction to ascertain the locations of existing services on or adjacent to site.
- 5.2 Information as to the location of existing services, if shown on the Drawings, does not relieve the Contractor of his responsibility to determine the exact number and location of existing services.
- 5.3 Give proper notices for new services as may be required. Make arrangements with authorities and utilities for service connections required.
- 5.4 Pay any charges levied by utilities or authorities for work carried out by them in connection with this Contract, unless specified otherwise.
- 5.5 Operate and maintain all utility systems affected by work of this Contract, until the building or specific portions thereof have been accepted by the Owner.
- 5.6 Report existing unknown services encountered during excavation to Consultant for instructions; cut back and cap or plug unused services. Be responsible for the protection of all active services encountered and for repair of such services if damaged.

6 SCAFFOLDING, HOISTS AND CRANES

- 6.1 Select, operate, and maintain scaffolding, hoisting equipment and cranes as may be required.

6.2 Do not erect or operate equipment that will endanger existing structures, local municipalities hydro installations, or traffic signals.

6.3 Design and construct scaffolding in accordance with CAN/CSA S269.2-M.

7 **TEMPORARY WORKS**

7.1 Installation and Removal: Provide temporary utilities, facilities, controls, and as otherwise necessary to perform the Work expeditiously. Remove from Site all such Work after use.

7.2 Pay all costs for temporary works consumed prior to completion of Contract.

7.3 If Owner's utilities and systems are used during the Work, ensure that systems manufacturers' warranties do not commence until the date of Ready-for-Takeover or, if manufacturers' warranties do commence earlier when systems are put into use, arrange for necessary extension of manufacturers' warranties or provide equivalent coverage under Contractor's warranty.

7.4 Temporary Power and Lighting Systems:

- .1 Supply, install and maintain electrical power and necessary electrical equipment including overhead and underground feeders, transformers, motors, starters, panels, protective devices and equipment. Connections will be made available to any part of the Work within distance of a 30 m extension.
- .2 Provide temporary lighting inside and outside structure of adequate intensity to illuminate construction activities. Provide temporary pedestrian lighting for sidewalk areas affected by the Work.
- .3 In locations approved by the Consultant. install and support the electrical plant, distribution and temporary lighting systems including service equipment and local hydro authority meter energized by the local hydro circuits. Installations shall be approved by the Consultant and shall be carried out in a neat manner to avoid interference with the application of finish material and to facilitate removal when the installed permanent lighting system is in operation.
- .4 Make all necessary arrangements for a temporary electrical service of sufficient capacity to supply temporary lighting, operation of power tools, cranes 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.
- .5 Temporary power distribution wiring shall comply with local Hydro Electrical Safety Code. Obtain inspection certificates for temporary electrical work.
- .6 Maintain the lighting systems in operation during the life of the Contract. Replace burned or missing lamps immediately.
- .7 Upon completion of Contract, remove electrical plant and temporary lighting from the Site.

7.5 Water Supply:

- .1 Provide and pay for a continuous supply of potable water for construction use. Provide as a minimum one water connection on each floor level.
- .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.

7.6 Temporary heating:

- .1 Provide temporary heating and ventilation 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 10°C 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 the Work free from fumes, vapours, exhaust and combustion gases, and other hazardous, noxious, or volatile substances in enclosed spaces, as required to maintain a safe work environment meeting applicable regulatory requirements.
- .5 Ventilate temporary sanitary facilities.
- .6 The permanent heating system of the building or portions thereof may be used when available only upon written permission by Consultant. If permission to use heating system is obtained:
 - .1 Before using air handling systems, ensure that dust/debris is removed from the premises and install temporary filters to prevent construction dust/debris from entering via return air or intake openings. Keep unused ducts sealed to prevent entry of dust/debris. Replace filters frequently during construction.
 - .2 On completion of work, remove temporary filters and install new filters in accordance with Division 23. After temporary use of air handling system is complete and before turning over system to Owner, vacuum internally to ensure all dust/debris is removed.

7.7 Elevators:

- .1 Permanent elevators may not be used by construction personnel.

7.8 Sanitary Facilities:

- .1 Provide sanitary facilities in accordance with occupational health and safety requirements in the place of the Work. Use of new sanitary facilities is not allowed.
- .2 Keep sanitary facilities clean and fully stocked with the necessary supplies.

8 **PROTECTION**

8.1 Protection of Public Area: Protect surrounding private and public property from damage during performance of the Work.

8.2 Take all necessary precautions to prevent damage to work affected by temperature, water, weather and other environmental conditions.

8.3 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 Provide temporary weather tight, dust tight, and lockable partitions within the building where work is performed. Provide weather tight closures to unfinished door and window openings, top of shafts and other openings in floors and roofs.
- .6 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.
- .7 Protect finished surfaces of new work from damage by restriction of access or by use of physical means suitable to the material and surface location. Where construction operations must be performed or traffic routed over finished floors, lay 6 mm plywood coverings tightly fitted and secured over surface in such areas.

8.4 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 Excessive storage of flammable liquids and other hazardous materials is not allowed on Site. Flammable liquids must be handled in approved containers. Remove combustible wastes frequently.
- .3 Inspect temporary wiring, drop cords, extension cables for defective insulation or connections frequently.
- .4 Open burning of rubbish is not permitted on the Site.
- .5 Handle, transport, store, use and dispose of gasoline, benzene or other flammable materials with good and safe practice as required by authorities having jurisdiction.
- .6 Provide fire extinguishers of the non-freezing chemical type in each temporary building, enclosure and trailer. Use only fire-proofed tarpaulins.
- .7 A fire watch shall be required for each of the following activities regardless of the number, duration or size of the activity in operation:
 - .1 any open flame activities(e.g., soldering and welding);
 - .2 shutdown of fire detection system;
 - .3 shutdown of sprinkler system.

8.5 Maintain adequate cover over services as required by Utility Authorities.

8.6 Report any discharge of a contaminant to the Authorities having jurisdiction.

9 **TEMPORARY BUILDINGS**

- 9.1 Provide, and maintain until contract completion a temporary office as required for work, large enough to accommodate site administrative activities and site meeting, complete with lighting, heating, and air conditioning equipment to maintain 21 °C. Ventilation, telephone, facsimile machine on a separate line, copier (not combination fax/copier), table and chairs. Do not store materials, tools. equipment in meeting area; keep clean and tidy.
- 9.2 For all trailers and temporary buildings, provide wood stairs, platform and boardwalk, painted and repainted as required with non-skid abrasive paint.
- 9.3 Do not locate any buildings, structures or equipment in a manner that interferes with surveys along the control line and reference line tangents.
- 9.4 Remove temporary buildings upon completion of Contract. Restore area(s) to match the existing surrounding area.

10 **PEST CONTROL**

- 10.1 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.

11 **FIRST-AID FACILITIES**

- 11.1 Provide site equipment and medical facilities necessary to supply first-aid service to injured personnel in accordance with regulations of the Workmen's Compensation Act. Maintain facilities for duration of Contract.

12 **USE OF NEW PERMANENT SERVICE & EQUIPMENT**

- 12.1 Do not use any new permanent service or equipment without Owner's written approval.
- 12.2 Where permission is granted to use permanent services and equipment provide competent persons to operate services and equipment; inspect frequently and maintain facilities in proper operating condition at all times.
- 12.3 Permanent services and equipment shall be turned over to Owner in "as new" and perfect operating condition.
- 12.4 Use of permanent systems and equipment as temporary facilities shall not affect the warranty conditions and warranty period for such systems and equipment. Make due allowance to ensure that Owner will receive full benefits of equipment manufacturers warranty after project takeover.

13 **PROJECT IDENTIFICATION**

- 13.1 If required, obtain approvals from jurisdictional authorities for temporary signs.
- 13.2 No other signs or advertisements, other than safety, warning, or directional signs, are permitted without the Consultant's and Owners written consent.
- 13.3 Maintain signs in good condition for the duration of Contract.

14 **SITE MAINTENANCE**

- 14.1 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.

- 14.2 When the Work is substantially performed, remove surplus Products, tools, construction machinery and equipment not required for the performance of the remaining Work.

15 **SITE STORAGE AND OVER LOADING**

- 15.1 Confine the Work and operations of employees to limits indicated by the Contract Documents. Do not unreasonably encumber the Site with Products.
- 15.2 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.
- 15.3 Fabrication shops shall not be set up within the structure except as directed by or with the permission of the Consultant.
- 15.4 Do not load or permit to be loaded any part of the Work with a weight or force that it is not 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.
- 15.5 Do not cut, drill or sleeve load bearing members unless shown on drawings or otherwise approved by the Consultant in writing for each location.
- 15.6 Site storage and loading requirements to be in accordance with the local Occupational Health and Safety Act and Regulations for Construction Projects.

16 **PUBLIC CONVENIENCE AND SAFETY**

- 16.1 Maintain sidewalks at and adjacent to the Site in a safe condition throughout the Contract. Promptly remove ice and snow.
- 16.2 Keep haul routes free at all times from Products spilled on highway or street surfaces and clean highways and streets of deposits due to performance of the Work to the satisfaction of the Consultant and the highway and street authorities. Clean highways and streets within 24 hours of Consultant's instruction.
- 16.3 The Consultant may inspect haul routes, the Site and adjacent premises daily and may halt operations, withhold payment or carry out such additional operations as necessary, deducting the cost from monies due, or to become due, to the Contractor.

17 **VEHICULAR ACCESS**

- 17.1 Provide and maintain adequate access to Place of the Work.

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- 17.2 Existing roads at Place of the Work may be used for access to Place of the Work, provided Contractor assumes responsibility for any damage caused by construction traffic, and prevents or promptly cleans up any mud tracking or material spillage.
- 17.3 Where construction requirements demand, construct access roads capable of withstanding construction equipment and haul traffic. Maintain access roads in good condition at all times. Remove access roads prior to completion of the Work unless otherwise noted and restore area as shown on the Contract Drawings.
- 18 **CONSTRUCTION PARKING**
- 18.1 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.
- 19 **PUBLIC TRAFFIC FLOW**
- 19.1 Provide and maintain flag persons, Police Officers, traffic signals, barricades and illumination as required by Authorities having jurisdiction and/or as necessary to perform the Work and protect the public.
- 20 **PUBLIC UTILITIES AND SERVICES**
- 20.1 Verify limitations imposed on project work by presence of utilities and services, and ensure no damage occurs to them.
- 20.2 Notify service authorities concerned so that they protect, remove, relocate, or discontinue them, as they may require.
- 20.3 Make arrangements and pay for connection charges for services required for project work.
- 20.4 Locate poles, pipes, conduit, wires, fill pipes, vents, regulators, meters, and sanitary services work in inconspicuous locations. If not shown on Drawings, verify location of service work with Consultant before commencing installation.
- 21 **ROADS, CURBS, GUTTERS, AND WALKS**
- 21.1 Include all curb cuts and making good of existing curbs, walks and paving on Municipal property to provide fully paved and finished approaches to requirements of authorities having jurisdiction.
- 22 **SITE VISITORS**
- 22.1 During the progress of the Work, afford access to visitors duly authorized by the Consultant and facilitate inspections or tests they may desire to make. Record site visitors in log book maintained on site.
- 22.2 Ensure Site visitors wear appropriate safety apparel.

23 EROSION AND SEDIMENTATION CONTROL

- 23.1 Control drainage on site to prevent flooding, erosion and run-off onto adjacent properties as a result of construction operations.
- 23.2 Dispose of water containing silt in suspension in accordance with requirements of jurisdictional authorities.
- 23.3 Conform to sedimentation and erosion control requirements of the conservation and/or municipal authority having jurisdiction. Provide and maintain until completion of work or until directed by Consultant to be removed, sediment control devices at catch basins, drainage courses and at other locations on site as directed. Comply with requirements of the local Conservation Authority.
- 23.4 Minimize amount of bare soil exposed at one time. Stabilize disturbed soils as quickly as practical to minimize erosion. Remove accumulated sediment resulting from construction activity from adjoining surfaces, drainage systems, and watercourses, and repair damage caused by soil erosion and sedimentation.
- 23.5 Do not disturb existing embankments or embankment protection.
- 23.6 Provide storm drain inlet protection consisting of a sediment control barrier or an excavated ponding area around storm drain inlet or curb inlet; add bracing where necessary to withstand high flow volumes and depth. Inspect inlet protection after each rainfall and repair damage. Sweep up accumulated sediment and dispose of in a controlled area. Remove inlet protection after area has been stabilized with permanent vegetation.
- 23.7 Periodically inspect erosion and sediment control measures to detect evidence of erosion and sedimentation. Promptly take corrective measures when necessary.
- 23.8 If soil and debris from site accumulate in ditches or other low areas, remove accumulation and restore area to original condition.
- 23.9 Prevent tracking of mud and dirt from site onto paved roads. Provide stabilized vehicle access/egress points, constructed of coarse granular material. Place additional granular material as required to maintain access/egress points in proper working order. Clean mud and dirt from paved roads at end of each day by shoveling or sweeping and subsequent washing. Dispose of mud dirt in a controlled disposal area.

24 TEMPORARY DRAINAGE AND DEWATERING

- 24.1 Prevent surface water runoff from leaving the Site unless approved by authorities having jurisdiction.

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- 24.2 Drainage lines, trenched, and gutters shall be kept open at all times. No flow of water shall be directed across or over pavements except through pipes or properly constructed troughs. Keep all portions of Work properly and efficiently drained during construction and until completion. Be responsible for all disturbances, dirt and damage which may be caused by or result from water backing up or flowing over, through, from or along any part of Work, or due to operations which may cause water to flow elsewhere.
- 24.3 Keep trenches and other excavations free of water at all times. Employ adequate means to remove water in a manner that will prevent loss of soil, and maintain the stability of excavation.
- 24.4 Dispose of such water in a manner that will not be dangerous to public health, private property or to any portion of Work completed or under construction, nor which causes an impediment to the use of streets by the public.
- 24.5 Drainage of trenches or other excavation through newly laid storm drainage pipe will be allowed only with the express permission of the authority having jurisdiction.
- 24.6 When drainage is directed to existing catch basins, regularly inspect and clean such catch basins of debris and sediment.
- 24.7 Prevent precipitation from infiltrating or from directly running off stockpiled [waste] materials. Cover stockpiled materials with an impermeable liner during periods of work stoppage including at end of each Working Day.
- 24.8 Control surface drainage from cuts and fills, from borrow and waste disposal areas, from stockpiles, staging areas, and other work areas as required to prevent erosion and sedimentation.
- 25 **SNOW REMOVAL**
- 25.1 Allow no accumulation of ice and snow on Site, and on roof deck when roofing operations are scheduled to take place.
- 25.2 Remove snow from access road, Site circulation paths and elsewhere as required to permit access to Work, parking and uninterrupted construction progress.
- 26 **POLLUTION (DUST, DEBRIS, AND NOISE) CONTROL**
- 26.1 Implement and maintain pollution control measures in accordance with applicable regulatory requirements.
- 26.2 Take measures to prevent contamination of soil, water, and atmosphere through uncontrolled discharge of noxious or toxic substances and other pollutants, potentially causing environmental damage.
- 26.3 Execute Work by methods that minimize dust from construction operations and spreading of dust on site or to adjacent properties.
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- 26.4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.
- 26.5 Keep premises free of waste material.
- 26.6 Arrange and pay for removal of all waste generated by the work in manner acceptable to authorities having jurisdiction.
- 26.7 Limit noise levels in accordance with requirements of authorities having jurisdiction.
- 26.8 Maintain temporary erosion and pollution control features installed under this contract.
- 26.9 Control emissions from equipment and plant to local authorities emission requirements.
- 26.10 Prevent abrasive-blasting and other extraneous materials from contaminating air beyond application area, by providing temporary enclosures.
- 26.11 Use appropriate covers on trucks hauling fine, dusty, or loose materials.
- 26.12 Take immediate action to contain and mitigate harmful effects of the spill or release.

27 TREE AND PLANT PROTECTION

- 27.1 Within Contractor's assigned work and storage areas, where indicated on drawings, and adjacent to designated access routes, protect existing trees and plants scheduled to remain. Provide minimum 1.8 m high chain link fencing or other barriers outside of dripline of trees or groups of trees and other plants in accordance with authorities having jurisdiction.
- 27.2 Leave fenced areas undisturbed; do not use areas for storage, stockpiling or any other purpose. Do not dump or flush any contaminants in areas of tree feeder roots.
- 27.3 Do not attach rigging cables to trees.
- 27.4 Where limbs or portions of plants are required to be removed to accommodate new work, they shall be removed in accordance with accepted arboricultural practice.
- 27.5 For trees designated to remain, protect roots inside dripline from disturbance or damage during excavation and grading. Avoid traffic, dumping and storage of materials over root zones.
- 27.6 Where root systems of protected trees adjacent to construction are exposed or damaged, they shall be neatly trimmed and the area backfilled with suitable material to prevent desiccation.
- 27.7 Where necessary give trees an overall pruning to restore the balance between roots and top growth and/or to restore appearance.

- 27.8 Except at locations where specific procedures are included in Contract Documents do not alter grades around existing trees/plants without first obtaining Consultant's consent and directions.
- 27.9 Minimize stripping of topsoil and vegetation.

END OF SECTION

1 SPECIFIED PRODUCTS

- 1.1 Work of this Contract is based on Products specified by:
- .1 Manufacturer's catalogued trade names and/or;
 - .2 References to standards (i.e. CAN, CGSB, CSA, ASTM) or;
 - .3 Prescriptive Specifications or;
 - .4 Performance Specifications.
- 1.2 When one Product or manufacturer is specified by a single proprietary name, Provide the named Product only. Products by other manufacturers are subject to the Consultant's acceptance as an equivalent substitution in accordance with Section 01 25 00.
- 1.3 When more than one Product or manufacturer is specified along with a referenced standard, any one of the specified Products or manufacturer's will be acceptable on condition the Product complies with the referenced standard.
- 1.4 Whenever a Product is specified by reference to a standard only, Provide any Product that meets or exceeds the specified standard for the intended purpose. The onus shall be on the Contractor to establish that such Products meet the reference standard requirements. Products exceeding minimum requirements established by reference standards will be accepted for the Work if such Products are compatible with the Work with which they are incorporated. If requested by Consultant, submit information verifying that the proposed Product meets or exceeds the specified standard.
- 1.5 Whenever a Product is specified by prescriptive or performance requirements only, Provide any Product that meets or exceeds the specified requirements. If requested by Consultant, submit information verifying that the proposed Product meets or exceeds the specified standard.
- 1.6 When a Product is specified by reference to a standard or by prescriptive or performance requirements only, upon request of the Consultant, obtain from the manufacturer, an independent testing laboratory report showing that the Product meets or exceeds the specified requirements.
- 1.7 Provide Products that are not damaged or defective, and suitable for purpose intended, subject to specified requirements. If requested by Consultant, furnish evidence as to type, source and quality of Products provided.
- 1.8 Unless otherwise indicated in the Specifications, maintain uniformity of manufacture for any particular or like item throughout the Work.

2 **APPROVAL OF PRODUCTS AND INSTALLATION METHODS**

- 2.1 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.

3 **PRODUCT DELIVERY CONTROL**

- 3.1 It is the responsibility of the Contractor to ensure that the supplier or distributor of materials specified or alternatives accepted, which he intends to use, has materials on the site when required. The Contractor shall obtain confirmed delivery dates from the supplier.
- 3.2 Promptly upon Contract award and periodically during construction, review and confirm Product availability and delivery times. Order Products in sufficient time to meet the construction progress schedule and the Contract Time.
- 3.3 Contact the Consultant immediately upon receipt of information indicating that the specified Product is no longer available or if any material or item, will not be available on time, in accordance with the original schedule.
- 3.4 The Consultant reserves the right to receive from the Contractor at any time, upon request, copies of actual purchase or work orders of any material or products to be supplied for the work.
- 3.5 If materials and products have not been placed on order, the Consultant may instruct such items to be placed on order, if direct communication in writing from the manufacturer or prime suppliers is not available indicating that delivery of said material will be made in sufficient time for the orderly completion of the Work.
- 3.6 The Consultant's review of purchase orders or other related documentation shall in no way release the Contractor, or his subcontractors and suppliers from their responsibility for ensuring the timely ordering of all materials and items required, including the necessary expediting, to complete the work as scheduled in accordance with the Contract Documents.
- 3.7 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.
- or

- .3 Request Contractor to propose actions to maintain the construction progress schedule for Consultant's review and acceptance.

4 **TRADEMARKS AND LABELS**

- 4.1 Permanent labels, trademarks and nameplates on Products are not acceptable in the finished Work, except where required by authorities having jurisdiction, for operating instructions, or when located in service rooms.
- 4.2 Remove trademarks and labels by grinding, if necessary, painting out where the particular surface is being painted, or if on plated parts, replace with new plain plated or non-ferrous metal parts.

5 **DELIVERY, STORAGE, HANDLING AND PROTECTION**

- 5.1 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.
- 5.2 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.
- 5.3 Ensure that Products, while transported, are not exposed to an environment which would increase their moisture content beyond the maximum specified.
- 5.4 Organize delivery of materials, Products and equipment to, and removal of debris and equipment from, the site and surrounding property.
- 5.5 Schedule early delivery of Products to enable Work to be executed without delay. Before delivery, arrange for receiving at the Place of the Work.
- 5.6 Coordinate mechanical and electrical equipment and apparatus deliveries with the manufacturer's and suppliers such that equipment and apparatus is delivered to the site when it is required, or so that it can be stored within the building and protected from the elements.
- 5.7 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.
- 5.8 Deliver packaged Products, in original unopened wrapping or containers, with manufacturer's seals and labels intact.
- 5.9 Label packaged products to describe contents, quantity, and other information as specified.

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- 5.10 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.
 - 5.11 Label fire-rated Products to indicate Underwriters' Laboratories approval.
 - 5.12 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.
 - 5.13 Do not obstruct or disrupt local traffic flow during construction period.
 - 5.14 Allocate an area within the limits of the Work acceptable to the Owner for storage of Products brought to the site by all trades. Keep storage area tidy at all times and do not use other parts of the property for storage. Arrange and pay for off-site storage when required.
 - 5.15 Locate products on site in a manner to cause minimal interference with the Work.
 - 5.16 Adequately protect parts of the Work completed and in progress from any kind of damage.
 - 5.17 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.
 - 5.18 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.
 - 5.19 Do not place or store materials and Products in corridors, public areas, streets, lanes, passageways or similar locations.
 - 5.20 Do not load or permit to be loaded any part of the Work with a weight or force that will endanger the safety or integrity of the Work.
 - 5.21 Store Products subject to damage from weather in weatherproof enclosures.
 - 5.22 Store cementitious Products clear of earth or concrete floors, and away from walls.
 - 5.23 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.
 - 5.24 Store sheet materials and lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.

- 5.25 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.
- 5.26 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.
- 5.27 Protect prefinished metal surfaces by protective coatings or wrappings until time of final cleanup specified in Section 01 74 00. Protection shall be easily removable under work of Section 01 74 00 without damage to finishes. Do not permit strippable tape or coatings to become baked on surfaces which they protect.
- 5.28 Touch-up damaged factory finished surfaces to Consultant's satisfaction. Use primer and paint to match original.
- 5.29 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.
- 5.30 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 of the material and surface location.
- 5.31 Adequately protect trowelled concrete floors from damage. Take special measure when moving heavy loads or equipment on them.
- 5.32 Keep finished concrete floors 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.
- 5.33 Protect finished flooring from pedestrian traffic with reinforced kraft paper as a minimum, secured in place and with joints sealed by reinforced pressure sensitive tape. Maintain protection in place until contract completion.
- 5.34 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.
- 5.35 Promptly remove, replace, clean, repair, or make good as directed by Consultant, work damaged as a result of inadequate protection.

6 **HAZARDOUS MATERIALS INFORMATION**

- 6.1 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) in accordance with jurisdictional authorities.

- 6.2 Deliver copies of Safety Data Sheets (SDS) to the Consultant on all Products intended for use in the Work and designated as a "controlled product."

7 MANUFACTURER'S INSTRUCTIONS

- 7.1 Unless otherwise indicated in the Specifications, fabricate, 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.
- 7.2 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.
- 7.3 Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.
- 7.4 Provide manufacturer's representatives with access to the Work at all times. Render assistance and facilities for such access so that manufacturer's representatives may properly perform their responsibilities.
- 7.5 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.

8 WORKMANSHIP

- 8.1 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.
- 8.2 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.
- 8.3 Decisions as to the quality or fitness of workmanship in cases of dispute rest solely with the Consultant, whose decision is final.
- 8.4 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.
- 8.5 Ensure that service poles, fill-pipes, vents, regulators, meters 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.

- 8.6 Ensure integrity of fire separations is maintained throughout the Work. When penetrating fire rated walls, ceiling, or floor assemblies, completely seal voids with fire-stopping materials, smoke seals, or both, in full thickness of the construction element as required to maintain the integrity of the fire rated assembly.
- 8.7 Finish access panels and doors to match adjacent wall and/or ceiling finish unless otherwise specified or indicated.
- 8.8 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.
- 8.9 Enforce fire prevention methods at site. Do not permit fires, open flame heating devices or accumulation of 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.
- 8.10 Where flammable materials are being applied, ensure that adequate ventilation is provided, spark-proof equipment is used, and smoking and open flames are prohibited.
- 9 DIMENSIONS**
- 9.1 Check all dimensions at the site before fabrication and installation commences and report discrepancies to the Consultant.
- 9.2 Where dimensions are not available before fabrication commences, ensure that dimensions required are agreed upon between the parties concerned.
- 9.3 Prior to commencing work, ensure that clearances required by jurisdictional authorities can be maintained
- 9.4 Wall thicknesses and openings shown on the drawings may be nominal only; ascertain actual sizes at the site.
- 9.5 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 by reason of non-compliance with this requirement.
- 9.6 Fabricate and erect manufactured items, shop fabricated items, and items fabricated on or off site, to suit site dimensions and site conditions.
- 9.7 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.
- 9.8 Leave areas clear where space is indicated to be reserved for future equipment, including access to such future equipment.

9.9 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.

10 **CONCEALMENT**

10.1 In finished areas, conceal pipes, ducts, conduit and wiring in floors, walls, ceilings, chases, or behind furring except where indicated otherwise:

- .1 After review by Consultant and authority having jurisdiction.
- .2 Where locations differ from those shown on Drawings, after recording actual locations on as-built drawings.

10.2 Provide incidental furring or other enclosures as required.

10.3 Notify Consultant in writing of interferences before installation.

11 **RELOCATION OF MECHANICAL AND ELECTRICAL ITEMS**

11.1 The mechanical and electrical drawings are intended to show approximate locations of mechanical apparatus, fixtures, equipment, piping and duct runs, electrical apparatus, fixtures, outlets, equipment, units, and conduit in diagrammatic form and wherein the mechanical and electrical items are not dimensioned, consider their locations to be approximate. Check the drawings and confer with the Consultant to determine the actual locations of these items as may be required to suit aesthetic and site conditions. Such relocation shall be done without change to the Contract Price.

11.2 Locate fixtures, outlets, and devices to provide minimum interference, maximum usable space, and as required to meet safety, access, maintenance, acoustic, and regulatory, including barrier free, requirements.

11.3 Promptly notify Consultant in writing of conflicting installation requirements for fixtures, outlets, and devices. If requested, indicate proposed locations and obtain approval for actual locations.

11.4 The Owner and the Consultant reserve the right to relocate outlets at a later date, but prior to installation, without additional cost to Owner, assuming that the relocation per outlet does not exceed 3000 mm from the original location. No credits will be anticipated where relocation per outlet of up to and including 3000 mm reduces materials, products and labour.

11.5 Should relocations per outlet exceed 3000 mm from the original location the Contract Price will be adjusted in accordance with the provisions for changes in the Contract Documents.

11.6 Alter the location of pipes and other equipment, without additional cost to the Owner, if approved, provided the change is made before installation.

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- 11.7 Make necessary changes, due to lack of coordination, as required and when approved, at no additional cost, to accommodate structural and building conditions.
- 12 **EXPANSION, CONTRACTION, AND DEFLECTION**
- 12.1 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 and contraction provisions provide inadequate.
- 12.2 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.
- 12.3 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.
- 12.4 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.
- 13 **DIELECTRIC SEPARATION**
- 13.1 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.
- 14 **PRODUCTS AT SOUND ATTENUATING PARTITIONS**
- 14.1 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.
- 15 **FASTENINGS**
- 15.1 Include in the work of each section necessary fastenings, anchors, inserts, attachment accessories, and adhesives. Where installation of devices is in work or other sections, deliver and locate devices in ample time for installation.
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- 15.2 Do not install fibre, plastic or wood plugs or blocking for fastenings in masonry, concrete, or metal construction, unless specified or indicated on drawings.
- 15.3 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.
- 15.4 Provide metal fastenings and accessories in same material, texture, colour, sheen and finish as metal on which they occur, unless indicated otherwise.
- 15.5 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.
- 15.6 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior Work, high humidity spaces, and where attached to, or contained within, exterior walls and slabs, unless stainless steel or other material is specified. Leave steel anchors bare where cast in concrete.
- 15.7 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.
- 15.8 Conceal fasteners where indicated. Keep exposed fastenings to a minimum, space evenly and in an organized symmetrical pattern.
- 15.9 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- 15.10 Bolts shall not project more than one diameter beyond nuts.
- 15.11 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.
- 15.12 Powder Actuated Fastenings:
- .1 Do not use powder actuated fasteners for the support of ceilings.
 - .2 Do not use powder actuated fastenings on any portion of the Work, unless written consent for a specific use is obtained from the Consultant.
 - .3 Only low velocity tools will be permitted under any condition. Operators to be qualified and to be in possession of a valid operator's certificate.
- 16 **ADJUSTING**
- 16.1 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.

- 16.2 Verify that work functions properly and adjust it accordingly to ensure satisfactory operation. Lubricate Products as recommended by manufacturer.

END OF SECTION

1 LAYOUT AND SURVEY

- 1.1 Engage a registered land surveyor, licensed to practice in Place of the Work.
- 1.2 Existing grades, lines, and site conditions shown on drawings were taken from survey information established by persons engaged directly by the Owner. The accuracy of survey information is not the Consultant's responsibility. The Contractor will establish location of property lines.
- 1.3 Be responsible for setting out the Work. Prior to setting out the Work, verify dimensions and elevations shown on the Contract Documents and report to the Consultant any unsatisfactory conditions that may adversely affect the proper completion of the Work.
- 1.4 Prior to starting work at Site, set up and maintain permanent reference points and be responsible for the accuracy of such reference points. Preserve and protect permanent reference points on site during construction. Establish lines and levels required for the performance of the Work.
- 1.5 Report to Consultant when a reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations. Require registered land surveyor to replace reference points in accordance with original survey. Do not change or relocate reference points without prior written notice to Consultant.
- 1.6 Accurately set out the Work from levels and lines. Where Work of this Contract is dependent upon grades and elevations of existing structures or facilities, such grades or elevations shall take precedence over those determined by reference to established elevations. Advise the Consultant of any discrepancies.
- 1.7 During any activity of the Work, layout and check all features, including but not limited to the following:
 - .1 Lay out building on the Site.
 - .2 Establish a permanent bench mark, or markers as widely separated as possible.
 - .3 Establish and maintain temporary bench marks set in suitable locations.
 - .4 Provide general dimensions, lines and elevations required by Subcontractors.
 - .5 Verify elevations of floor and roof levels as construction proceeds and relate to bench mark datum.
 - .6 Verify that present or known future restrictions are not violated by construction on the site or lines of traverse to all public utilities.
 - .7 Correlate geodetic elevation of bench mark datum with elevations in use by public utilities adjacent to Project.
 - .8 Verify accuracy of site dimensions shown on Drawings.

- .9 Provide a survey to verify location of footings immediately adjacent to property lines, before construction of footings proceeds.
- .10 Provide a survey to verify location of building related to property lines when foundation walls are completed to grade level.
- .11 Provide a survey prior to placement of asphalt and concrete paving to confirm that grades conform to grades indicated on drawings.
- .12 Provide a survey to verify location of completed building on Site.
- 1.8 Maintain a complete, accurate log of control and survey work as it progresses. Record locations with horizontal and vertical data in project record documents.
- 1.9 Examine, preserve and protect established bench marks. Re-establish a lost or displaced bench mark by a Land Surveyor licensed to practice in the place of Work at no cost to the Owner. Accept responsibility for setting out the Work.
- 1.10 In the event of a discrepancy between the Owner and the Contractor regarding horizontal and/or vertical alignment conditions, that are beyond allowable specified tolerance, the Owner may engage the services of an independent Land Surveyor. The surveyor shall investigate the disputed condition and the results of the independent investigation shall determine the bearer of costs for this service, being either the Owner or the Contractor.
- 1.11 If the Contractor is found to be in error, all costs incurred to correct the condition shall be assumed by the Contractor.

2 EXISTING UTILITIES AND STRUCTURES

- 2.1 Before commencing excavation, drilling or other earthwork, establish or confirm location and extent of all existing underground utilities and structures in work area.
- 2.2 Promptly notify Consultant if underground utilities, structures, or their locations differ from those indicated in Contract Documents or in available project information. Consultant will provide appropriate direction.
- 2.3 Record locations of maintained, re-routed and abandoned utility lines.

3 VERIFICATION OF EXISTING CONDITIONS

- 3.1 Where work specified in any Section is dependent on the work of another Section or Sections having been properly completed, verify that work is complete and in a condition suitable to receive the subsequent work. Commencement of work of a Section that is dependent on the work of another Section or Sections having been properly completed, means acceptance of the existing conditions.

- 3.2 Verify that ambient conditions are suitable before commencing the work of any Section and will remain suitable for as long as required for proper setting, curing, or drying of Products used.
- 3.3 Ensure that substrate surfaces are clean, dimensionally stable, cured and free of contaminants.
- 3.4 Notify Consultant in writing of unacceptable conditions.

END OF SECTION

1 GENERAL

- 1.1 Provide labour, Products, equipment, services, tools, and supervision necessary for cutting and patching work in accordance with the Contract Documents.
- 1.2 Obtain Consultant's approval prior to cutting, boring or sleeving load-bearing members.

2 DEFINITION(S)

- 2.1 The terms "make good", "making good", "made good", "restore to existing", "patch", "repair", or similar words or phases are used in standards and these Contract Documents to mean the following, unless context provides otherwise:
 - .1 Make good materials and finishes which are damaged or disturbed during the process of additions and reconstruction under the Contract.
 - .2 Where existing work is to be made good, match new work exactly with the existing work in material, form, construction and finish unless otherwise noted or specified.
 - .3 Where existing work is to be made good, there shall be no visible difference in appearance, or aesthetics between the existing work and the new work by the naked eye at a distance of 3 metres [10 feet] from the surface being made good. There shall be no difference in performance between existing materials and new materials.

3 SUBMITTALS

- 3.1 Submit written request in advance of cutting or alteration which affects:
 - .1 Structural integrity of any element of the Structure or Contract.
 - .2 Integrity of weather-exposed or moisture-resistant elements.
 - .3 Efficiency, maintenance, or safety of any operational element.
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of Owner's or Other Contractors.
 - .6 Warranty of Products affected.
- 3.2 Include in request:
 - .1 Identification of Project.
 - .2 Location and description of affected Work, including drawings and sketches as required.
 - .3 Statement of necessity for cutting or alteration.
 - .4 Description of proposed Work and Products to be used.

- .5 Alternatives to cutting and patching.
- .6 Effect on work of Owner's or Other Contractors.
- .7 Written permission of affected Other Contractors.
- .8 Date and time Work will be executed.

3.3 Obtain Consultant's approval of proposed method of cutting prior to proceeding with the Work.

4 PRODUCTS

- 4.1 Same quality or better than Products incorporated in original installation.
- 4.2 Unless otherwise specified, when replacing existing or previously installed Products in the course of cutting and patching work, use replacement Products of the same character and quality as those being replaced.
- 4.3 If an existing or previously installed Product must be replaced with a different Product, submit request for substitution in accordance with Section 01 25 00.

5 PREPARATION

- 5.1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- 5.2 After uncovering, inspect conditions affecting performance of the Work.
- 5.3 Beginning of cutting or patching means acceptance of existing conditions.
- 5.4 Provide supports to assure structural integrity of surroundings; Provide devices and methods to protect other portions of the Work from damage.
- 5.5 Provide protection from elements for areas which may be exposed by uncovering Work; maintain excavations free of water.

6 EXECUTION

- 6.1 Coordinate and perform the Work to ensure that cutting and patching work is kept to a minimum.
- 6.2 Execute Work to avoid damage to other Work.
- 6.3 Ensure that cutting, patching, and remedial work does not jeopardize manufacturers' warranties.
- 6.4 Perform cutting, fitting, patching, and remedial work [including excavation and fill,] to make the affected parts of the Work come together properly and complete the Work.

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- 6.5 Perform cutting, patching, and remedial work using competent and qualified specialists familiar with the Products affected, in a manner that neither damages nor endangers the Work.
 - 6.6 Fit Work segments together, to integrate with penetrations through surfaces and with other Work.
 - 6.7 Remove and replace defective and non-conforming Work.
 - 6.8 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.
 - 6.9 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
 - 6.10 Execute Work by methods to avoid damage to other Work and which will provide proper surfaces to receive patching and finishing.
 - 6.11 Cut Products using proper equipment and methods. On rigid materials, use a masonry saw or core drill. Do not use pneumatic or impact tools without Consultant's prior approval.
 - 6.12 Where new Work connects with existing structures, cut, patch and make good existing work to match original condition.
 - 6.13 Be responsible for correct formation and bridging of openings in masonry and structural walls as required.
 - 6.14 Ensure compatibility between installed Products and security of installation.
 - 6.15 Restore Work with new Products in accordance with requirements of the Contract Documents.
 - 6.16 Fit Work airtight to pipes, sleeves, ducts, conduits and other penetrations through surfaces.
 - 6.17 Provide proper surfaces to receive patching, remedial work, and finishing.
 - 6.18 Refinish surfaces to match adjacent finishes. For continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.
 - 6.19 Fit work to pipes, sleeves, ducts, conduit, and other penetrations through surfaces with suitable allowance for deflection, expansion, contraction, acoustic isolation, and firestopping.
 - 6.20 Maintain fire ratings of fire rated assemblies where cutting, patching, or remedial work is performed. Completely seal voids or penetrations of assembly with firestopping material to full depth or with suitably rated devices

6.21 Existing utilities:

- .1 When breaking into or connecting to existing services' utilities, execute the Work at times directed by local governing authorities, with a minimum of disturbance to the Work, pedestrian and vehicular traffic, and ongoing Owner operations. Inform Owner and Consultant a minimum of 72 hours prior to breaking into or connecting to existing services' and utilities.
- .2 Maintain excavations free of water.
- .3 Keep duration of interruptions to a minimum.
- .4 Carry out interruptions after regular working hours of occupants, preferably on weekends, unless Owner's prior written approval is obtained.
- .5 Protect and maintain existing active services. Record location of services, including depth, on as-built drawings.
- .6 Construct or erect barriers in accordance local governing authorities as required to protect pedestrian and vehicular traffic.

END OF SECTION

1 **REGULATORY REQUIREMENTS**

- 1.1 Comply with applicable regulatory requirements when disposing of waste materials.
- 1.2 Obtain permits from authorities having jurisdiction and pay disposal fees where required for disposal of waste materials and recyclables.

2 **GENERAL CLEANING REQUIREMENTS**

- 2.1 Provide adequate ventilation during use of volatile or noxious substances. Do not rely on building ventilation systems for this purpose.
- 2.2 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- 2.3 Prevent cross-contamination during the cleaning process.
- 2.4 Notify the Consultant of the need for cleaning caused by Owner or other contractors.

3 **PROGRESS CLEANING AND WASTE MANAGEMENT**

- 3.1 Maintain the Work in a tidy and safe condition, free from accumulation of waste materials and construction debris.
- 3.2 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.
- 3.3 Provide appropriate, clearly marked, containers for collection of waste materials and recyclables.
- 3.4 Remove waste materials and recyclables from work areas, separate, and deposit in designated containers at end of each Working Day. Collect packaging materials for recycling or reuse.
- 3.5 Maintain building work areas "broom clean" at least on a daily basis, but shall also be done immediately before finishing work.
- 3.6 Remove from finish work, spatters, droppings, soil, labels, and debris, before they set up.
- 3.7 No waste material may be burned or buried at site. Remove as often as required to avoid accumulation, no less than, at the end of each working day.
- 3.8 Remove packaging materials and debris from the site immediately after product and equipment is unwrapped or uncrated.
- 3.9 Ensure that volatile fluid wastes are not disposed of in storm or sanitary sewers, in open drain courses, or anywhere on site.

- 3.10 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.
- 3.11 Clean interior building areas prior to start of finish work and maintain free of dust and other contaminants during finishing operations.
- 3.12 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.
- 3.13 Provide instructions for final cleaning of finishing work, and for inclusion in Maintenance and Operating Manuals.

4 FINAL CLEANING

- 4.1 In addition to requirements for progress cleaning, Work shall include final cleaning by professional cleaning specialists on completion of construction.
- 4.2 Before final cleaning, arrange a meeting at Place of the Work to determine the acceptable standard of cleaning. Ensure that Owner, Consultant, Contractor and cleaning company are in attendance.
- 4.3 Remove from Place of the Work surplus Products, waste materials, recyclables, Temporary Work, and Construction Equipment not required to perform any remaining work.
- 4.4 Before final inspection, replace glass and mirrors broken, damaged, and etched during construction, or which are otherwise defective.
- 4.5 Remove waste material and debris from crawlspaces and other accessible concealed spaces.
- 4.6 Remove temporary protections and make good defects before commencement of final cleaning.
- 4.7 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 exterior paved surfaces, and of interior stone, brick, and concrete floors.
 - .2 Remove stains, spots, marks, and dirt from exterior facades.
 - .3 Clean exterior and interior window glass and frames.
 - .4 Cleaning and polishing of glass, mirrors, porcelain, enamel and finish metals.

- .5 Remove dust from lighting reflectors, lenses, lamps, bulbs, and other lighting surfaces.
- .6 Vacuum cleaning of ceilings, walls and floors, and behind grilles, louvres and screens.
- .7 Washing clean of glazed wall surfaces.
- .8 Cleaning of hardware, mechanical fixtures, plumbing fixtures, lighting fixtures, cover plates, and equipment, including polishing of their finish metal, porcelain, vitreous, and glass components. Replace filters for mechanical equipment if equipment is used during construction.
- .9 Cleaning of windows and entrances, both interior and exterior surfaces.
- 4.8 Lock or otherwise restrict access to each room or area after completing final cleaning in that area.
- 4.9 Re-clean as necessary areas that have been accessed by Contractor's workers prior to Owner occupancy.
- 5 **WASTE AUDIT, MANAGEMENT AND DISPOSAL**
- 5.1 Dispose of waste materials and recyclables at appropriate municipal landfills and recycling facilities in accordance with applicable regulatory requirements.
- 5.2 Deliver to nearest appropriate depot all materials accepted for recycling by the region or municipality having jurisdiction over the Place of Work, including but not limited to cardboard, paper, plastic, aluminum, steel, and glass. Deliver to nearest appropriate depot all scrap and excess gypsum wallboard for recycling of this material. Pay all costs for this work.
- 5.3 Do not burn or bury waste materials at Place of the Work.
- 5.4 Do not dispose of volatile and other liquid waste such as mineral spirits, oil, paints and other coating materials, paint thinners, cleaners, and similar materials together with dry waste materials or on the ground, in waterways, or in storm or sanitary sewers. Collect such waste materials in appropriate covered containers, promptly remove from Place of the Work, and dispose of at recycling facilities or as otherwise permitted by applicable regulatory requirements.
- 5.5 Cover or wet down dry waste materials to prevent blowing dust and debris.

END OF SECTION

1 DEMONSTRATION AND INSPECTION OF PRODUCTS AND SYSTEMS

- 1.1 Arrange for a demonstration of equipment, systems and operating Products upon the 100% completion of their installation, testing, adjusting and balancing has been performed, equipment and systems are fully operational, completed operation and maintenance manual is available, and prior to application for Ready-for-Takeover.
- 1.2 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.
- 1.3 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.
- 1.4 Subcontractor to demonstrate start up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment and system.
- 1.5 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.
- 1.6 Submit report(s) within 5 Working Days after completion of demonstration and inspection:
 - .1 Identifying time and date of each demonstration and training session,
 - .2 Summarizing the demonstration and training performed, and
 - .3 Including a list of attendees.
- 1.7 Submit copies of letters from manufacturers of Systems and/or Products before making application for Ready-for-Takeover to verify that the Products have been installed and connected correctly, and that they are 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.
- 1.8 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.

2 FINAL INSPECTIONS AND CLOSE OUT

- 2.1 Submit proposed closeout procedures and schedule of inspection to Consultant for approval before final demonstrations and inspections commence.

- 2.2 Submit layout and survey requirements required by Owner and Authorities having jurisdiction.

3 **CERTIFICATE OF COMPLIANCE**

- 3.1 Submit Certificates of Compliance, prior to the application for Ready-for-Takeover for each of the following items.

- .1 An affidavit relative to the use of lead-free solder for all domestic water lines, regardless of location.
- .2 Products for which Safety Data Sheets have been submitted and accepted.
- .3 Other Work/Products identified in the Contract Documents as requiring a Certificate of Compliance.

- 3.2 Each Certificate of Compliance shall indicated names and addresses of the project, the Owner, the date of issue, product description including name, number, manufacturer, with a statement verifying that the Work/Product installed meets specified requirements and, if applicable, complies with the submitted and accepted Safety Data Sheets.

- 3.3 Each Certificate of compliance shall be issued on the subcontractor's letterhead, properly executed, under whose work the prospective Work/Product has been provided.

- 3.4 Each Certificate of Compliance shall be endorsed by the Contractor with his authorized stamp/signature. Ensure that submissions are made to allow sufficient time for review without delaying progress of scheduled completion.

4 **READY-FOR-TAKEOVER**

- 4.1 The prerequisites to attaining Ready-for-Takeover of the Work are described in the General Conditions of the Contract.

5 **INSPECTION AND REVIEW BEFORE READY-FOR-TAKEOVER**

- 5.1 Contractor's Inspection: Before applying for the Consultant's review to establish Ready-for-Takeover of the Work:

- .1 Ensure that the specified prerequisites to Ready-for-Takeover of the Work are completed.
- .2 Conduct an inspection of the Work to identify defective, deficient, or incomplete work.
- .3 Prepare a comprehensive and detailed list of items to be completed or corrected.
- .4 Provide an anticipated schedule and costs for items to be completed or corrected.

- 5.2 Consultant's Review: Upon receipt of the Contractor's application for review, together with the Contractor's list of items to be completed or corrected, the Consultant and the Contractor shall arrange a mutually satisfactory agreed date and time to jointly review the Work. The Consultant will advise the Contractor whether or not the Work is Ready-for-Takeover and will add additional items, if any, to the Contractor's list of items to be completed or corrected. Provide the Consultant with a copy of the revised list.
- 5.3 Maintain the list of items to be completed or corrected and promptly correct or complete defective, deficient and incomplete work. The Contractor's inspection and Consultant's review procedures specified above shall be repeated until the Work is Ready-for-Takeover and no items remain on the Contractor's list of items to be completed or corrected.
- 5.4 When the Consultant determines that the Work is Ready-for-Takeover, the Consultant will notify the Contractor and the Owner in writing to that effect.

6 PREREQUISITES TO FINAL PAYMENT

- 6.1 After Ready-for-Takeover of the Work and before submitting an application for final payment in accordance with the General Conditions of Contract:
- .1 Correct or complete all remaining defective, deficient, and incomplete work.
 - .2 Remove from the Place of the Work all remaining surplus Products, Construction Equipment, and Temporary Work.
 - .3 Perform final cleaning and waste removal necessitated by the Contractor's work performed after Ready-for-Takeover, as specified in Section 01 74 00.

7 SUBSTANTIAL PERFORMANCE OF THE WORK

- 7.1 The prerequisites to, and the procedures for, attaining Substantial Performance of the Work, or similar such milestone as provided for in the lien legislation applicable to the Place of the Work, shall be:
- .1 Independent of those for attaining Ready-for-Takeover of the Work, and
 - .2 In accordance with the lien legislation applicable to the Place of the Work.

END OF SECTION

1 **GENERAL**

- 1.1 Prepare closeout submittals and comprehensive operation and maintenance manual, using personnel qualified and experienced for this task.
- 1.2 Hand over to the Consultant two (2) copies of closeout submittals and comprehensive operations and maintenance manual and material suitable for the Owner's maintenance employees. Manuals shall cover all Products supplied and installed under the Contract.
- 1.3 Submit draft of closeout submittals including 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.
- 1.4 Submit final version of operation and maintenance manuals prior to Contract Completion.
- 1.5 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 Consultant.
- 1.6 If standard literature is incorporated into the operations and maintenance manual, any irrelevant information shall be deleted, or suitably noted.
- 1.7 The manuals shall have sufficient detail in order that the Owner can totally maintain the equipment without outside help.
- 1.8 Submit all material in English.

2 **FORMAT**

- 2.1 Organize data in the form of an instructional manual.
- 2.2 Binders: Commercial quality, 216 x 279 mm, maximum "D" ring size.
- 2.3 When multiple binders are used, correlate data into related consistent groupings.
- 2.4 Cover: Identify each binder with type or printed title "Contract Record Documents"; list title of Contract, identify subject matter of contents.
- 2.5 Arrange content by systems or process flow, under Section numbers and sequence of Table of Contents.
- 2.6 Provide tabbed fly leaf for each separate Product and system, with typed description of Product and major component parts of equipment.
- 2.7 Provide tabbed fly leaf for Products and systems which are supplied by the Owner but installed as part of the Work of this Contract.
- 2.8 Text: Manufacturer's printed data, or typewritten data and on 20 pound paper.

2.9 Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

2.10 Provide electronic copy of manual in PDF format.

2.11 Provide electronic copy of Shop Drawings in manual as 1:1 scaled CAD files in .dwg format on electronic media acceptable to Owner.

3 **OPERATION AND MAINTENANCE MANUAL CONTENT**

3.1 Operation and maintenance manuals shall contain the following minimum information and data:

.1 Table of contents.

.2 Introductory information:

.1 Provide date of manual submission.

.2 Title of Contract, complete contact information for Consultants, subconsultants, Contractor, and subcontractors with name of responsible parties.

.3 Schedule of Products and systems, indexed to content of the volume.

.3 For each Product or system: Include complete contact information for Subcontractors, suppliers, manufacturer's, and service representatives, including local source of replacement supplies and parts.

.4 Product Data:

.1 Mark each sheet to clearly identify specific products, options, and component parts, and data applicable to installation. Delete or strike out inapplicable information. Supplement with additional information as required.

.2 Drawings: Supplement Product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams and as required in the Specifications.

.3 Typed text: As required to supplement Product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions and as required in the Specification.

.5 Complete set of reviewed Shop Drawings.

.6 Permits, certificates, letters of assurance and other relevant documents issued by or required by authorities having jurisdiction.

.7 Warranties: Warranties are between the Contractor and Owner. Warranties shall include, as a minimum:

.1 Separate each warranty with index tab sheets keyed to Table of Contents listing.

.2 List each warrantor with complete contact information.

.3 Verify that documents are in proper form and contain full information. Ensure that warranties are for the correct duration and are in Owner's name.

- .4 Description of warranty coverage.
- .5 Date warranty starts (being date of Ready-for-Takeover).
- .6 Date warranty expires.
- .7 Contact name, address and phone number (the Contractor shall also be responsible for advising the Owner of changes in contact information during the warranty period).
- .8 Equipment and components performance curves.
- .9 Hydro certificates.
- .8 Reports: For each Product or system provide the following:
 - .1 Manufacturer's certified reports.
 - .2 Factory test reports.
 - .3 Field testing reports.
- .9 Details of design, construction and/or fabrication features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of the installation.
- .10 Technical data, Product data, supplemented by bulletins, component illustrations, detailed views, technical descriptions of items and parts lists.
- .11 Operating and maintenance procedures, incorporating manufacturer's operating and maintenance instructions, in a logical sequence.
- .12 Equipment and systems content:
 - .1 Each item of equipment and each system: Include description of unit or system and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
 - .2 Schematic and wiring diagrams, wiring interconnection lists and diagrams fully cross referenced and coordinated, printed circuit board layouts including the component identification, component parts list with electronic substitution equivalent. Provide cross referenced components lists and sequence of operations.
 - .3 Panel board circuit directories: Provide electrical service characteristics, controls, and communications.
 - .4 Include installed colour coded wiring diagrams.
 - .5 Operating procedures: Include start up, break in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut down, and emergency instructions. Include summer, winter, and any special operating instructions.
 - .6 Maintenance requirements: Include routine procedures and guide for trouble shooting and fault location; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
 - .7 Provide servicing, preventative maintenance, and lubrication schedule, and list of lubricants required.
 - .8 Include manufacturer's printed operation and maintenance instructions.
 - .9 Include sequence of operation by controls manufacturer.

- .10 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
 - .11 Provide installed control diagrams by controls manufacturer.
 - .12 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.
 - .13 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
 - .14 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
 - .15 Include testing and balancing reports.
 - .16 Include additional content as specified in technical Specifications sections.
- .13 Product and finishes:
- .1 Include Product data, with specific Product, component parts, and catalogue number, options selected, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured Products. Delete inapplicable information.
 - .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
 - .3 Include an outline of requirements for routine and special inspections and for regular maintenance to ensure that on-going performance of the building envelope will meet the initial building envelope criteria.
 - .4 Include additional content as specified in technical Specifications sections.
- .14 As-built drawings: Submit final as-built drawings in the form specified in Section 01 32 00.

4 **DRAWINGS**

- 4.1 Prepare all required drawings in an electronic format acceptable to Owner.
- 4.2 Supply and hand over to the Consultant electronic files for each final drawing prepared under this Contract, including but not limited to circuit drawings, equipment layout drawings, and shop drawings.
- 4.3 The final size of drawings shall be 560 mm x 860 mm. Half size reproductions (280 mm x 430 mm) shall also be provided.
- 4.4 Prior to Ready-for-Takeover, supply and hand over to the Consultant, one complete set of electronic drawing files on storage media acceptable to Consultant for each final drawing prepared under this Contract, including but not limited to circuit drawings, equipment layout drawings, and shop drawings.
- 4.5 Text files shall be written in word processing program acceptable to Owner.

5 **TRANSMITTAL**

- 5.1 Forward storage media to the Owner through the Consultant with a transmittal form. Transmittal shall contain the list of file names contained on the storage media.
- 5.2 Data forwarded to the Owner shall contain the following files in addition to the design information:
 - .1 Library parts used in the design files.
 - .2 Level convention used for each design file.
 - .3 Plotting instructions used to prepare hard copies including colour tables, pen tables and plot scale.
 - .4 Working units of the design files.
 - .5 Font library, if the standard is not used.

6 **PROJECT RECORD DRAWINGS**

- 6.1 Transfer all information marked up on the as-built drawings during the progress of the Work to a master set of record drawing files provided by Consultant, in electronic format agreed to with Owner.
- 6.2 Mark revised drawings as "RECORD DRAWINGS".
- 6.3 Submit completed record drawings in electronic form to Owner.

7 **SPARE PARTS, MAINTENANCE MATERIALS AND SPECIAL TOOLS**

- 7.1 Supply spare parts, maintenance materials, and special tools in quantities specified in technical Specifications sections.
- 7.2 Ensure spare parts and maintenance materials are new, not damaged nor defective, and of same quality, manufacturer, and batch or production run as installed Products.
- 7.3 Provide tags for special tools identifying their function and associated Product.
- 7.4 Deliver to and store items at location directed by Owner at Place of the Work. Store in original packaging with manufacturer's labels intact and in a manner to prevent damage or deterioration.
- 7.5 Catalogue all items and submit to Consultant an inventory listing organized by Specifications section. Include Consultant reviewed inventory listing in operation and maintenance manual.

END OF SECTION

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 the receipt of the Work of this Contract, including not necessarily limited to:
 - .1 Demolition of existing building.
 - .2 Demolition of ancillary buildings indicated.
 - .3 Alteration and renovations to existing building.
 - .4 Cutting and removing of walls, floors, ceilings, doors and frames , in the existing buildings as indicated on Drawings.
 - .5 Patching, making good openings and chases in walls, floors, ceilings, including the supply and installation of lintels, channels and finishes.
 - .6 Removal of rubbish, debris, demolished fixtures, fitments and items not scheduled to remain the Owner's property, resulting from the demolition and preparatory work.
 - .7 Remove abandoned services such as conduits, pipes, wiring, ducts, fixtures, equipment, etc. where required for the work or indicated on the drawings.
 - .8 Removal of asphalt pavements, concrete curbs and walks, and other site amenities as indicated on drawings.
 - .9 Removal of all mechanical items including plumbing fixtures, services etc. where required for the work or indicated on drawings and or where not required to be relocated.
 - .10 Removal of existing electrical items including fixtures, etc. where required for the work or indicated on the drawings and not required to be relocated.
 - .11 Dust control during the operations of the work of this Section.
 - .12 Removal shall mean removal from site and safe disposal in a legal manner.
 - .13 Any additional items as indicated on the drawings or by the Consultant.

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 the Conditions of the Contract.
- .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 Owners operations.
- .5 Submit Dust Control Plan conforming to requirements of the City of Toronto's Public Health Services.
- .6 Have submissions signed and sealed by Professional Engineer licensed in Province of Ontario.
- .7 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.
- .8 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 time or times that will permit uninterrupted operations in and around structures, including parking, deliveries, and Site access and egress.
- .3 Take over structures to be demolished based on condition on date that Tenders close.

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 Temporary Protection:
 - .1 Provide temporary hoarding consisting of 16 mm plywood sheathing, metal studs and 16 mm plywood sheathing in areas shown on Drawing.
 - .2 Provide temporary hoarding consisting of 16 mm plywood sheathing, metal studs and 16 mm plywood sheathing with lock-able access door in areas shown on Drawing. 16 mm plywood sheathing, metal studs and 16 mm plywood sheathing in areas shown on Drawing.
 - .3 Provide 1 hr rated temporary hoarding ULC 407 with lock-able access door.
- .3 Salvaged material:
 - .1 Salvage and stockpile Products, materials, and equipment as specified herein, indicated on Site or indicated on drawings.
 - .2 Coordinate items to be salvaged with Consultant.
 - .3 Salvaged materials shall not be chipped, cracked, split, stained or damaged.
 - .4 Store items off of moist surfaces.

3 Execution

3.1 **GENERAL**

- .1 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.
- .2 Stockpiling of rubble, debris, and surplus Products on Site will not be permitted.
- .3 Remove, handle and transport Products indicated 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.
- .4 List and description of items to be removed and stored or reused:
 - .1 Existing Electrical and Mechanical fixtures.
 - .2 Existing Tires to be relocated as per Drawings.
 - .3 Existing doors to be relocated as per Drawings.
 - .4 Salvage existing lockers to be reinstalled in new location.
 - .5 Salvage existing door to be reinstalled in new location.
 - .6 Salvage existing brick to be reinstalled in new location.
 - .7 All items as indicated on the drawings or by the Consultant.

- .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 Communicate Dust Control Plan procedures to all appropriate personnel on site and their head offices and due diligence measures to be maintained to control all fugitive emissions.
- .7 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.

3.2 **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 Examine adjacent structures and other installations prior to commencement of demolition and removals work.

3.3 **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.

3.4 **PROTECTION**

- .1 Provide, erect and maintain required hoarding, sidewalk sheds, catch platforms, lights and other protection around Site before commencing work. Maintain such areas free of snow, ice, mud, water and debris. Lighting levels shall be equal to that prior to erection.
- .2 Prevent movement or damage of adjacent structures, 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.
- .3 Protect adjacent structures and property against damage which might occur from falling debris or other causes. Repair or replace damage caused from work of this Section to acceptance of Consultant.
- .4 Do not interfere with use of adjacent structures and Work areas. Maintain free, safe passage to and from adjacent structures and Work areas.

- .5 Take precautions to support affected structures. If safety of structure being demolished, adjacent structures 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.
- .6 If movement or settlement occurs, install additional bracing and shoring as necessary and make good damage to acceptance of Consultant.
- .7 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.
- .8 Prevent debris from blocking surface drainage system, elevators, mechanical, and electrical systems which are required to remain in operation.
- .9 Pay particular attention to prevention of fire and elimination of fire hazards which would endanger Work or adjacent structures and premises.
- .10 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.
- .11 Close off access to areas where demolition is proceeding by barricades and post warning signs.
- .12 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.
- .13 Dust protection:
 - .1 Perform dust control procedures in accordance with approved Dust Control Plan and work of this Section.
 - .2 Clean water to be applied to hard and soft surfaces and on open excavation faces on Site daily to eliminate dust.
 - .3 Roadways and sidewalks to be cleaned daily or as required.
 - .4 A designated truck loading area on granular material or existing asphalt to be used to mitigate tracking of potentially contaminated soil and demolition debris off Site. Contaminated loading points to be cleaned or re-established.
 - .5 Loaded vehicles leaving Site to be cleaned of loose soil and debris with power washing or alternative method.
 - .6 Trucks loaded with indigenous soil or demolition debris to be covered by tarps or attached screens.
 - .7 Cover existing intake ducts with HEPA filter.
- .14 Blasting is not permitted.

3.5 **PREPARATION**

- .1 Disconnect and/or re-route electrical data, communication and telephone service lines entering structures to be demolished. Remove abandoned lines as indicated on Contract Drawings. Post warning signs on electrical lines and equipment which is required to remain energized.
- .2 Disconnect and cap designated mechanical services:
 - .1 Natural gas supply lines: As indicated on drawings, to be removed by gas company.
 - .2 Sewer and water lines: Remove and dispose of as indicated on Contract Drawings.
 - .3 Other underground services: Remove and dispose of as indicated on Contract Drawings.
- .3 Disassemble and remove mechanical equipment, ductwork and piping complete with supports and associated components.
- .4 Do not disrupt active or energized utilities designated to remain undisturbed.
- .5 Perform rodent and vermin control to comply with health regulations.

3.6 **CONCRETE CUTTING AND CORING**

- .1 Prior to cutting or coring any concrete slab, suspended or on grade, or any concrete beam, investigate by telemetrically scanning the element for presence of embedded services (piping, cabling, conduit, etc.), and for locations of reinforcing steel in suspended concrete slabs and beams.
- .2 Acceptable telemetric scanning systems include:
 - .1 X-Ray scanning of suspended slabs and for concrete beams.
 - .2 (Ground-penetrating) radar for slab on grade, for suspended slabs and for concrete beams.
- .3 Magnetic radio scanners not acceptable for telemetric scanning.
- .4 The term x-rays include gamma ray methods, and procedures that use electrically generated x-rays.
- .5 Where x-rays employed:
 - .1 Provide Owner minimum 5 working days advance notice of scanning time in order to provide sufficient advance notice to personal that may be affected by the x-ray work.
 - .2 Conform to Owner's radiation protection requirements prior to start of any x-ray work.
- .6 Provide Owner and Consultant with inspection agency's written report, summarizing investigations and conclusions.

- .7 Obtain Consultant's direction where investigations reveal that cutting or coring required in Contract would cut or damage embedded services, or cut or damage reinforcing steel in suspended concrete slabs or beams.
- .8 Execute cutting and coring to prevent damage to all embedded services. Make good all damage arising from cutting embedded services.
- .9 Execute cutting and coring to prevent damage (cutting in whole or in part) reinforcing steel in suspended concrete slabs with Consultant's prior authorization.
- .10 Make good all damage arising from cutting reinforcing steel in suspended concrete slabs and beams.

3.7 **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 Demolish parts of structure to permit remedial work as indicated.
- .5 Demolition shall proceed safely in systematic manner from roof to grade and as necessary to accommodate remedial work indicated. Work on each floor level shall be complete before commencing work on supporting structure and safety of its supports are impaired. Parts of building which would otherwise collapse prematurely shall be securely shored. Walls and piers shall not be undermined.
- .6 Do not overload floor or wall with accumulations of material or debris or by other loads.
- .7 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.
- .8 Do not sell or burn materials on Site.
- .9 Remove existing equipment, services, and obstacles where required for refinishing or making good of existing surfaces, and replace as Work progresses.
- .10 At end of day's work, leave Work in safe condition with no part in danger of toppling or falling. Protect interiors of parts not to be demolished from exterior elements.
- .11 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 Guelph Sewer Use By-Law.
- .12 Concrete:
 - .1 Demolish concrete by methods which avoid impact loads on items which are not to be demolished.
 - .2 Where only part or parts of a concrete floor, wall, roof, foundation or other items are to be demolished, use saw cuts to isolate areas which are to be demolished except where existing reinforcing steel is to be left in place. Prior to such isolating, install suitable support to prevent premature movement of area(s) being isolated and undesirable transfer of loads as cutting progresses. If necessary remove area(s) to be demolished by successively isolating small sections.
 - .3 Where reinforcing steel is to be left in place, use saw cuts from surface of concrete around perimeter(s) of area(s) to be demolished, chip concrete without damaging reinforcing steel. Retouch damaged epoxy coating of existing reinforcing steel.
- .13 Masonry:
 - .1 Demolish block or brick walls in small sections of not more than 2 m². Do not permit masonry to fall in mass from one level to another.
 - .2 Where only part(s) of a wall is to be demolished, install adequate support for adjacent part(s).
 - .3 After removal of masonry walls, grind smooth floors ready for new floor finish.
 - .4 Salvage masonry for reuse or turnover to Owner as noted in demolition Drawings.
- .14 Steel: Where only part or parts of structure is to be demolished, dismantle and maintain structure stable. Do not place excessive loads on components. Install adequate temporary guys and supports to ensure stability and to prevent excessive loading. Support each component being disconnected from structure, and lower, do not drop, component after it is disconnected.
- .15 Cut openings through existing walls, partitions, roofs and floors. Establish exact location of steel reinforcing in existing concrete slabs or walls before cutting. Be responsible for damage to existing steel reinforcing and be liable for structural failure. Make good surfaces disturbed with materials to match existing..
- 16. Where doors are scheduled to be removed, include removal of door frames and door hardware.
- 17. Remove interior partitions, fittings, fixtures and accessories as indicated on drawings. Partitions and walls shall be removed full height to structure above.
- 18. Remove interior finishes, such as ceiling and floor finishes, where new finishes are indicated on Room Finish Schedule.
 - 1. Removal of existing ceilings shall include complete removal including bulkheads and suspension system.

2. Removal of adhesive applied finishes shall include complete removal to substrate including adhesive. Take adequate care to prevent damage to substrate.
- .19 Remove existing floor finishes, include mortar bed, underlayment or other cleavage membranes, underpad, base, floor moulding and transition strips.
- .20 Where 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.
- .21 Where acoustic ceiling tiles are indicated for removal and subsequent reinstallation, the tile are to be removed and stored on site in a dry and safe location approved with the Consultant and Owner. The suspension system and framing is to be removed only as required for work above the ceiling, and subsequently re-installed with the ceiling tiles.
22. Demolish all other items indicated or required.

3.8 **RECYCLING**

- .1 Whenever possible, all materials shall be recycled. Pay all costs for this work.
- .2 Deliver to nearest appropriate recycling depot all materials accepted for recycling by Authorities having jurisdiction over the Place of Work, including but not limited to cardboard, paper, plastic, aluminum, steel, and glass.
- .3 Deliver to nearest appropriate depot all scrap and excess gypsum wallboard for recycling of this material.
- .4 Ceiling tiles to be stacked on skids and wrapped for recycling and delivered to nearest appropriate recycling depot.
- .5 Carpet tile to be recycled by Viking Recycling or by Interface (only when a new order is placed).
- .6 Base building light fixture lamps to be placed on skids and wrapped for recycling and delivered to nearest appropriate recycling depot.

3.9 **DISPOSAL OF MATERIALS**

- .1 Remove from Site, rubble, debris, and other materials that can not be recycled 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.

3.10 RESTORATION

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

END OF SECTION

1 General

1.1 **RELATED REQUIREMENTS**

- .1 Section 03 20 00 – Concrete Reinforcing
- .2 Section 03 30 00 – Cast-In-Place Concrete
- .3 Section 31 41 10 – Shoring for Excavation
- .4 Section 32 16 00 – Curbs, Gutters, Sidewalks and Driveways

1.2 **References**

- .1 All referenced standards shall be the current edition, or the edition referenced by the Ontario Building Code in force at the time of building permit application.
- .2 Canadian Standards Association (CSA International):
 - .1 CSA-A23.1 / A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA-O86, Engineering Design in Wood.
 - .3 CSA O121, Douglas Fir Plywood.
 - .4 CSA O151, Canadian Softwood Plywood.
 - .5 CSA O153, Poplar Plywood.
 - .6 CAN/CSA-O325.0, Construction Sheathing.
 - .7 CSA O437 Series, Standards for OSB and Waferboard.
 - .8 CSA S269.1, Falsework for Construction Purposes.
 - .9 CAN/CSA-S269.3, Concrete Formwork, National Standard of Canada
- .3 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2 **QUALITY ASSURANCE**

- .1 In accordance with Section 01 43 00 – Quality Assurance.
- .2 Qualifications
 - .1 Engage a Professional Engineer licensed in the Province of Ontario to be responsible for design and installation of all formworks, falsework and re-shoring.
- .3 Samples

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts. Comply with CSA S269.1 and CAN/CSA-S269.3 as applicable.
- .3 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.
- .4 When slip or flying forms are used, submit details of equipment and procedures for review by the Consultant.

2 Products

2.1 DESIGN REQUIREMENTS

- .1 Design in accordance with CSA S269.1 and CSA S269.3
- .2 For multi-storey construction, ensure that sufficient re-shoring is provided to prevent overloading of the structure while constructing the work above.
- .3 Structural design of formwork, falsework and re-shoring will not be reviewed by the Consultant.

2.2 MATERIALS

- 1. Formwork materials: to CSA S269.1
 - .1 For concrete without special architectural features, use wood and wood product formwork materials to CSA-O121, CAN/CSA-O86, CSA O437 Series and/or CSA-O153 as appropriate.
 - .2 For concrete with special architectural features, use formwork materials to CSA-A23.1/A23.2.
 - .3 Rigid insulation board: to CAN/ULC-S701.
 - .4 Tubular column forms: round, spirally wound laminated fibre forms, internally treated with release material.
 - .1 Spiral pattern not to show in hardened concrete unless specifically noted on the architectural drawings.
 - .5 Form ties:
 - .1 For concrete not designated 'Architectural', use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm (1") diameter in concrete surface.
 - .2 For Architectural concrete, use snap ties complete with plastic cones and light grey concrete plugs.

2. Form liner:
 - .1 Architectural Finish:
 - .1 Plywood: high density overlay Douglas Fir to CSA O121.
 - .2 Non-Architectural Finish:
 - .1 Plywood: to CSA O151.
 - .2 Waferboard: to CAN/CSA-O325.0.
 - .3 Form release agent: non-toxic, biodegradable and low VOC.
 - .4 Form stripping agent: colourless mineral oil, non-toxic, biodegradable, low VOC, free of kerosene, with viscosity between 15 to 24 mm²/s at 40 degrees C, flashpoint minimum 150 degrees C, open cup.
 - .5 Falsework materials: to CSA-S269.1.
 - .6 Sealant: to Section 07 92 00 - Joint Sealants.
 - .7 Void Form: Cellular cardboard with minimum compressive strength of 62 kPa (9 psi) designed to carry weight of wet concrete and loads associated with placing concrete and designed to disintegrate and create an air space below the fully hardened concrete.
 - .8 Compressible Material: Ceramar by W. R. Meadows or equivalent.

2 Execution

2.1 FABRICATION AND ERECTION

1. Conform to CSA A23.1 and the following:
 - .1 Fabricate and erect falsework in accordance with CSA S269.1.
 - .2 Verify lines, levels and centres before proceeding with formwork / falsework and ensure dimensions agree with drawings.
 - .3 Do not use earth forms unless specifically noted on the structural drawings or approved by the Consultant.
 - .4 Refer to architectural drawings for concrete members requiring architectural exposed finishes.
 - .5 Do not place shores and mud sills on frozen ground.
 - .6 Provide site drainage to prevent washout of soil supporting mud sills and shores.
 - .7 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1/A23.2. Cambers required for hardened concrete are shown on the Drawings and are measured relative to member supports.
 - .8 Align form joints and make watertight.
 - .1 Keep form joints to minimum.
 - .9 Locate horizontal form joints for exposed columns 2400 mm (8'-0") above finished floor elevation.

- .10 Use 25 mm (1") chamfer strips on external corners and/or 25 mm (1") fillets at interior corners, joints, unless specified otherwise.
- .11 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .12 Do not substitute round concrete column forms in lieu of rectangular column forms unless specifically approved by the Consultant.
- .13 Use internal form ties.
- .14 Do not permit loads from formwork to be transmitted to adjacent existing structure.
- .15 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.
 - .1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
- .16 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.
- .17 Do not close formwork before reinforcing steel has been reviewed.
- .18 Void form:
 - .1 Conform to manufacturer's recommendations.
 - .2 Place on sand leveling bed.
 - .3 Protect from moisture until concrete is about to be placed.
 - .4 Protect from excessive construction loads.
 - .5 If void form collapses during construction, remove and replace affected area.
- .19 Concrete Exposed to View
 - .1 Minimize formwork joints. Locate joints and ties in a uniform pattern with no ties within 300mm (12") of an edge or joint.
 - .2 Make panels forming slab soffits and wall / beam faces as large as possible, and arrange symmetrically.
 - .3 Make form joints in columns level from column to column and consistent with form joints in other parts of the structure. Locate lowest horizontal form joints 2400mm (8'-0") above finished floor elevation.
 - .4 Where grooves, reglets or chamfers are shown, locate panel form joints behind them.
 - .5 Seal all joints in formwork and between formwork and concrete.
 - .6 Place 16 mm (5/8") bevel strips at member corners to form chamfers unless architectural details show an alternative profile. When beams are supported on columns of the same width, extend chamfer across face of column.
 - .7 Do not reuse formwork if there is any evidence of surface damage or wear, which could impair the visual quality of the concrete surface.
 - .8 Reuse forms only on identical sections, using the original tie holes. Clean forms and fill nail holes before reuse.
 - .9 Use only galvanized nails.
 - .10 Remove form tie plastic cones. Install concrete plugs where indicated. Recess 6mm (1/4") and bond to concrete using a cement slurry with a bonding agent conforming to Section 03 30 00.

2.2 REMOVAL AND RESHORING

1. Conform to CSA A23.1.
2. Remove formwork when concrete has reached 75 % of its design strength. Replace immediately with adequate reshoring where applicable.
3. Provide necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
4. Space reshoring in each principal direction at not more than 3000 mm (10'-0") apart.
5. Re-use formwork and falsework subject to requirements of CSA-A23.1/A23.2.

2.3 FIELD QUALITY CONTROL

1. Refer to Section 01 45 00 Quality Control.
2. The Contractor and their Engineer are duly responsible to perform General Review of the formwork, falsework and reshoring (as applicable).
 - .1 Submit General Review Reports for Record Purpose.
3. The Consultant will not review the suitability or dimensional accuracy of any formwork, falsework or reshoring while performing General Review of the Work.

END OF SECTION

1 General

1.1 **RELATED REQUIREMENTS**

- .1 Section 03 10 00 – Concrete Forming and Accessories
- .2 Section 03 30 00 – Cast-In-Place Concrete
- .3 Division 04 – Masonry
- .4 Section 32 16 00 – Curbs, Gutters, Sidewalks and Driveways

1.2 **REFERENCES**

- .1 All referenced standards shall be the current edition, or the edition referenced by the Ontario Building Code in force at the time of building permit application.
- .2 American Society for Testing and Materials (ASTM International):
 - .1 ASTM A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - .2 ASTM A143/A143M, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - .3 ASTM A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
- .3 Canadian Standards Association (CSA International):
 - .1 CSA-A23.1 / A23.2, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CAN/CSA-A23.3, Design of Concrete Structures.
 - .3 CSA-G30.18, Carbon Steel Bars for Concrete Reinforcement.
 - .4 CSA-G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .5 CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .6 CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .4 Reinforcing Steel Institute of Canada (RSIC):
 - .1 RSIC, Reinforcing Steel Manual of Standard Practice.

1.3 QUALITY ASSURANCE

- .1 Submit in accordance with Section 01 45 00 - Quality Control.
- .2 Qualifications
 - .1 Welding of reinforcing steel to be performed by welders certified under CSA W186.

1.4 QUALITY CONTROL

- .1 Submit in accordance with Section 01 45 00 - Quality Control.
- .2 Source Quality Control Submittals:
 - .1 Upon request, provide Consultant with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis.
 - .2 Upon request, inform Consultant of proposed source of reinforcement material to be supplied.
 - .3 Upon request, provide the Consultant with a copy of plant certificate by the Concrete Reinforcing Steel Institute for epoxy coating of reinforcement.
 - .4 Upon request, provide the Consultant with a copy of manufacturer's instructions for patching factory applied epoxy coating.
- .3 Bring to the attention of the Consultant any defects or deficiencies in the work together with a proposal for remedy. The Consultant will decide what corrective action may be taken and will issue the necessary instructions.
- .4 Construction Review:
 - .1 General review during construction by the Consultant will be carried out by examination of representative samples of the work.
 - .2 Do not close forms or pour concrete before reinforcing steel is reviewed.
 - .3 Construction review reports will outline any deficiencies found.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice.
- .3 Shop Drawings:
 - .1 Submit drawings indicating the placement of reinforcement and:
 - .1 Bar bending details.
 - .2 Bar Lists.
 - .3 Quantities of reinforcement.
 - .4 Sizes, spacings, locations of reinforcement and mechanical splices if approved by Consultant with identifying code marks to permit correct placement without reference to structural drawings.
 - .5 Concrete cover.

- .6 Splice lengths.
- .7 Standard hook lengths.
- .2 Detail lap lengths and bar development lengths to CAN/CSA-A23.3, unless otherwise indicated.
 - .1 Provide Class B tension lap splices unless otherwise indicated.
- .3 Provide 90° or 180° standard hooks to CAN/CSA-A23.3. Do not shorten hooks to accommodate member dimensions but rather rotate hooks in the member to maintain hook dimensions and adequate concrete cover.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with this 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.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

2 Products

2.1 MATERIALS

- .1 Reinforcing steel: billet steel, grade 400, deformed bars to CSA-G30.18, unless indicated otherwise.
- .2 Reinforcing steel: weldable low alloy steel deformed bars to CSA-G30.18.
- .3 Cold-drawn annealed steel wire ties: to ASTM A82/A82M.
- .4 Welded steel wire fabric: to ASTM A185/A185M.
 - .1 Provide in flat sheets only.
- .5 Epoxy Coating of non-prestressed reinforcement: to ASTM A775/A775M.
- .6 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.
- .7 Mechanical splices: to develop 120% of the specified yield strength of the reinforcing bar, subject to approval of the Consultant.
- .8 Plain round bars: to CSA-G40.20/G40.21.
- .9 Substitute different size bars only if permitted in writing by the Consultant.

3 Execution

3.1 **FABRICATION**

- .1 Fabricate reinforcing steel in accordance with CSA-A23.1/A23.2 Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
- .2 Obtain the Consultant's written approval for locations of reinforcement splices other than those shown on placing drawings.
- .3 Upon approval of the Consultant, weld reinforcement in accordance with CSA W186. Unless otherwise noted, weld to develop the yield force of the specified bar.
- .4 Stagger mechanical splices 750mm (2'-6") unless otherwise noted on drawings.

3.2 **FIELD BENDING**

- .1 Do not field bend or field weld reinforcement except where indicated or authorized by the Consultant.
- .2 When field bending is authorized, bend without heat, applying slow and steady pressure.
- .3 Unless specifically noted, the Contractor is responsible to retain the services of a qualified inspector to review the condition of field bent reinforcement not indicated on the Contract Documents.
- .1 Replace bars, which develop cracks or splits at no cost.

3.3 **PLACING REINFORCEMENT**

- .1 Place reinforcing steel as indicated on placing drawings and in accordance with CSA-A23.1/A23.2.
- .2 Remove all loose scale, dirt, oil or other coatings which would reduce bond.
- .3 Ensure cover to reinforcement is maintained during concrete pour.
- .4 Turn ends of tie wire towards the interior of concrete.
- .5 Use bar supports for beams and slabs.
- .6 Do not drive or force reinforcement into fresh concrete.
- .7 Prior to placing concrete, obtain the Consultant's General Review of reinforcing material and placement.
- .8 Ensure cover to reinforcement is maintained during concrete pour. Use side form spacers for walls and columns.
- .9 Do not splice reinforcing at locations other than shown on placing drawings without Consultant's written approval.
- .10 Do not cut reinforcement without Consultant's written approval.
- .11 Provide concrete chairs where supports rest on the ground.

- .1 Space chairs at 600 mm (2'-0") centres to support welded wire fabric in slabs-on-grade.
- .2 Do not lift reinforcement during slab-on-grade concrete placement.
- .12 Exposed concrete surfaces:
 - .1 Use plastic or plastic tipped bar supports and spacer with colour to match concrete.
- .13 Use plain round bars as slip dowels in concrete.
 - .1 Paint portion of dowel intended to move within hardened concrete with [one coat of asphalt paint].
 - .2 When paint is dry, apply thick even film of mineral lubricating grease.
- .14 Where drawings refer to welded deformed reinforcing bars, conform to CSA W186.

END OF SECTION

► General

1.1 **RELATED REQUIREMENTS**

- .1 Section 03 10 00 – Concrete Forming and Accessories
- .2 Section 03 20 00 – Concrete Reinforcing
- .3 Section 03 35 00 – Concrete Floor Finishing
- .4 Section 32 16 00 – Curbs, Gutters, Sidewalks and Driveways

1.2 **REFERENCES**

- .1 All referenced standards shall be the current edition, or the edition referenced by the Ontario Building Code in force at the time of building permit application.
- .2 American Society for Testing and Materials (ASTM International):
 - .1 ASTM
 - .2 C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.
 - .3 ASTM C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - .4 ASTM C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
 - .5 ASTM C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
 - .6 ASTM D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 - .7 ASTM D624, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.
 - .8 ASTM D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
 - .9 ASTM D1752, Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-37.2, Emulsified Asphalt, Mineral Colloid-Type, Unfilled, for Damp-proofing and Waterproofing and for Roof Coatings.
 - .2 CAN/CGSB-51.34, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .4 Canadian Standards Association (CSA International):
 - .1 CSA A23.1 / A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

- .2 CSA A283, Qualification Code for Concrete Testing Laboratories.
- .3 CSA A3000, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).

1.3 **ADMINISTRATIVE REQUIREMENTS**

- .1 Pre-installation Meetings: convene pre-installation meeting one week prior to beginning concrete works to verify project requirements. Ensure key personnel, site supervisor, speciality contractors (finishing, forming... etc.), concrete producer and testing laboratories attend.
- .2 Concrete Delivery Tickets: keep all concrete delivery tickets on site until building is complete. Record on each ticket when and where concrete was placed.
- .3 Batch Logs: keep record of each batch delivered to the site.
- .4 Record Drawings: Record on a set of Structural Drawings the extent of each pour including the pour date and falsework removal date. Record all field changes including footing elevations.

1.4 **QUALITY ASSURANCE**

- .1 In accordance with Section 01 45 00 - Quality Control.
- .2 Provide the Consultant, minimum 4 weeks prior to starting concrete work, with valid and recognized certificate from plant delivering concrete.
 - .1 Concrete supplier to have a valid "Certificate of Ready Mixed Concrete Production Facilities" issued by the relevant Ready Mixed Concrete Association.
 - .2 Concrete supplier's certification: both batch plant and materials meet CSA A23.1 requirements.
- .3 Samples and Mock-ups for architectural concrete
 - .1 Construct two architectural mock-up samples with dimensions of 300mm length by 600mm wide x 600mm high. One sample will be used to represent new concrete, and the other sample will be used to represent repair patch work.
 - .2 Use the same materials and workmanship as will be employed for the actual work.
 - .3 Include a repaired area for each mock-up sample.
 - .4 Concrete supplier's certification: both batch plant and materials meet CSA A23.1 requirements.

1.5 **QUALITY CONTROL**

- .1 Submit in accordance with Section 01 45 00 - Quality Control.
- .2 Provide test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture will meet specified requirements.

- .3 Minimum 4 weeks prior to starting concrete work, provide proposed quality control procedures for review by the Consultant on the following items:
 - .1 Hot weather concrete.
 - .2 Cold weather concrete.
 - .3 Curing.
 - .4 Finishes.
- .4 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, and air temperature and test samples taken.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Minimum four weeks prior to starting concrete work, provide valid certificate from plant delivering concrete and quality control plan.
- .3 Minimum 2 weeks prior to starting concrete work, submit all concrete mix designs, and indicate where each concrete mix is to be used.
- .4 Minimum 2 weeks prior to placing concrete, submit drawings showing locations of all construction joints and slab on grade control joints.
- .5 Minimum submission requirements for each concrete mix design shall include the following:
 - .1 Minimum specified compressive strength at 28-day.
 - .2 Maximum aggregate size.
 - .3 Aggregate type (if not normal density).
 - .4 Concrete density range, wet and dry (if not normal density).
 - .5 CSA exposure class.
 - .6 Cement type (if not type GU).
 - .7 Percentage and type of supplemental cementing materials.
 - .8 Maximum water/cementitious ratio.
 - .9 Assumed method of placement of concrete.
 - .10 Corrosion inhibitor (name and quantity, if applicable).
 - .11 Plastic or steel fibres (type, name and quantity, if applicable).
 - .12 Alkali-aggregate resistance.
 - .13 Architectural requirements (colour of cement and aggregate, if applicable).
 - .14 Maximum time from batching to placing concrete (if retarding admixtures are used).

- .6 Concrete pours: provide accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken as described in Execution.
- .7 Concrete hauling time: provide for review by the Consultant deviations exceeding maximum allowable time of 120 minutes for concrete to be delivered to site of Work and discharged after batching.
- .8 On completion of the concrete works, provide written report to the Consultant verifying compliance that concrete in place meets performance requirements of concrete as established in Products

.9 DELIVERY, STORAGE AND HANDLING

.10 Delivery and Acceptance Requirements:

- .1 Concrete hauling time: deliver to site of Work and discharged within 120 minutes maximum after batching.
 - .1 Do not modify maximum time limit without receipt of prior written agreement from the Consultant and concrete producer as described in CSA A23.1/A23.2.
 - .2 Deviations to be submitted for review by the Consultant.
- .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.

2 Products

2.1 DESIGN CRITERIA

- .1 Alternative 1 - Performance: to CSA A23.1/A23.2, and as described in Materials.

2.2 PERFORMANCE CRITERIA

- .1 Quality Control Plan: ensure concrete supplier meets performance criteria of concrete as established by the Consultant and provide verification of compliance as described in Quality Assurance.

2.3 MATERIALS

- .1 Portland Cement: to CSA A3001.
- .2 Supplementary cementing materials (SCM):
 - .1 Cementitious hydraulic slag: to CSA A3000
 - .2 Fly Ash: to CSA A3001, Type CI.
 - .3 Minimum two weeks prior to placing concrete, Concrete Supplier to provide written recommendation to reduce SCM content to accommodate anticipated environmental conditions.
- .3 Water: to CSA A23.1.
- .4 Aggregates: to CSA A23.1/A23.2. Do not use recycled concrete as aggregate.

- .5 Admixtures:
 - .1 Air entraining admixture: to ASTM C260.
 - .2 Chemical admixture: to ASTM C494.
 - .3 Chemical admixture: to ASTM C1017.
 - .4 Corrosion-inhibiting admixture: calcium nitrate solution.
 - .5 Not to contain chlorides.
- .6 Shrinkage compensating (non-shrink) grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents to CSA A23.1/A23.2.
 - .1 Compressive strength: 40 MPa at 28 days.
- .7 Non premixed dry pack grout: composition of non-metallic aggregate Portland cement with sufficient water for mixture to retain its shape when made into ball by hand
 - .1 Compressive strength: 50 MPa at 28 days.
- .8 Plastic Fiber additive: fibrillated polypropylene fibres at least 19mm (3/4") in length.
- .9 Steel Fiber additive: High strength steel wire at least 50 mm long with double hooked ends or flattened ends.
- .10 Dowels at steel fiber reinforced slab on grade at construction joints: smooth square bars with greased plastic sleeve on one end to allow for shrinkage parallel and transverse to joints and load transfer across the joints.
- .11 Curing compound: to CSA A23.1/A23.2 and ASTM C309 to be coordinated and compatible with surface floor hardeners where used.
- .12 Floor surface hardener: Non-metallic, natural grey colour (unless other colour is requested by the Architect), premixed, Mohs Hardness 7 or better.
- .13 Mechanical water--stops: ribbed extruded PVC with shop welded corners and intersecting pieces with legs not less than 250 mm (10") long:
 - .1 At construction Joints:
 - .1 Minimum thickness: 3 mm (1/8").
 - .2 Minimum width: 100 mm (4").
 - .2 At expansion Joints:
 - .1 Minimum thickness: XXX.
 - .2 Minimum width: 225 mm (9").
 - .3 Provide 32 mm (1 1/4") diameter centre bulb.
 - .3 Tensile strength: to ASTM D412, method A, Die "C", minimum 13 MPa.
 - .4 Elongation: to ASTM D412, method A, Die "C", minimum 275%.
 - .5 Tear resistance: to ASTM D624, method A, Die "B", minimum 50 kN/m.
 - .6 Low temperature brittleness: to ASTM D746, minimum -37°C.

- .7 Width in construction joints: 100mm (4").
- .8 Width in expansion joints: 225mm (9"), with 31mm (1-1/4") O.D. centre bulb.
- .14 Hydrophilic Waterstops: Krytonite™, trapezoidal, flexible, swellable, elastomeric.
- .15 Pre-moulded joint fillers:
 - .1 Bituminous impregnated fiber board: to ASTM D1751.
- .16 Weep hole tubes: plastic.
- .17 Dovetail anchor slots: minimum 0.6 mm (24 gauge) thick galvanized steel with insulation filled slots.
- .18 Polyethylene film (vapour barrier): 0.25 mm (10 mil) thickness to CAN/CGSB-51.34.
- .19 Bonding adhesive: Portland Cement grout
- .20 Bonding adhesive: Synthetic latex.
- .21 Rigid insulation: Extruded polystyrene boards per ASTM C578, structural grade, compressive strength 100 psi (690 kPa).
- .22 Control joint filler: semi-rigid filler to protect against slab edge breakdown:
 - .1 For saw-cuts made with "Soff-Cut" saw: two component epoxies.
 - .2 For conventional saw-cuts in interior slab: two component epoxy urethanes.
 - .3 For conventional saw-cuts in exterior slabs: two or multi component polyurethane based elastomeric.
- .23 Continuous sliding bearing:
 - .1 Two layers of polyolefin, or two layers of promine covered with rubber top and bottom, approximately 6mm (1/4") in overall thickness.
 - .2 Deformation under 13.8 MPa at 22°C not to exceed 10% when tested for 24 hours.
- .24 Elastomeric bearing pads:
 - .1 Virgin natural polyisoprene or virgin polychloroprene (Neoprene) conforming to CSA S6.
- .25 Sliding bearing assembly:
 - .1 Galvanized top steel plate (anchored to concrete with min. two 12mm (1/2") dia. anchor studs) with a type 304 stainless steel highly polished lower surface, and bottom elastomeric pad with a polytetrafluoroethylene (Teflon) upper surface, wrapped in watertight polyethylene wrapping.
 - .2 Static and kinetic coefficients of friction not to exceed 5% under working stress.
 - .3 Assembly to have a working stress capacity of 7 MPa on lower pad.
 - .4 Elastomeric bottom pad to allow a 2% rotation of upper plate and still maintain a substantially uniform bearing pressure between plate and pad.

- .26 Crack Filler: low viscosity epoxy resin.

2.4 MIXES

- .1 Use ready-mix concrete. Proportion concrete in accordance with Alternative 1 - Performance Method for specifying concrete to meet the Consultants performance criteria and to CSA A23.1/A23.2, whichever is more stringent.
 - .1 Ensure concrete supplier meets performance criteria as established below and provide verification of compliance as in Quality Control Plan.
 - .2 Provide concrete mix to meet following plastic state requirements:
 - .1 Workability: free of surface blemishes, loss of mortar, colour variations (in exposed elements) and segregation.
 - .2 As required by the trades placing and finishing the concrete.
 - .3 Provide concrete mixes to meet following hard state requirements:
 - .1 Durability and class of exposure: as indicated on the structural drawings.
 - .2 Compressive strength at 28 days (minimum): as indicated on the structural drawings.
 - .3 Intended application: as indicated on the structural drawings.
 - .4 Aggregate size 20 mm (3/4") maximum unless otherwise noted on the structural drawings.
 - .4 Supplementary cementing materials (SCM):
 - .1 Conform to CSA A23.1.
 - .2 Follow slag and fly ash manufacturers' directions for proportioning and mixing of concrete.
 - .3 Maximize SCM content in foundations, walls, columns and any other elements that do not require horizontal finished surface or rapid strength gain to permit early formwork stripping.
 - .4 Limit SCM content for floors with special finishes (such as Retroplate), to be compatible with the finish.

3 Execution

3.1 PREPARATION

- .1 Obtain written approval of each foundation bearing surface by the Geotechnical Consultant prior to placing concrete. Remove water and disturbed soil from excavations before placing concrete.
- .2 Provide 24 hours minimum notice prior to placing of concrete.
- .3 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.
- .4 During concreting operations:
 - .1 Development of cold joints not allowed.
 - .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.

- .5 Pumping of concrete is permitted only after approval of equipment and review of the proposed mix by the Concrete Supplier.
- .6 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .7 Protect previous Work from staining.
- .8 Clean and remove stains prior to application for concrete finishes.
- .9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .10 In locations where new concrete is dowelled to existing work, drill holes in existing concrete.
 - .1 Place steel dowels of deformed steel reinforcing bars grouted with Hilti HIT HY-200 V3 Adhesive Safe Set System with Hollow Drill Bit and Vacuum (or approved alternate) with standard embedment unless noted otherwise on the structural drawings.
- .11 Before placing slab-on-grade, confirm that subgrade and backfill meet specifications and are free of frost and surface water.
- .12 Provide vapour barrier under slabs placed on the ground including slabs-on-grade and framed slabs as described by the Architectural specifications.

3.2 **INSTALLATION/APPLICATIONS**

- .1 Do cast-in-place concrete work to CSA A23.1/A23.2.
- .2 Refer to Notes on Structural Drawings for maximum size and minimum spacing of embedded conduits.
- .3 Sleeves and inserts:
 - .1 Do not permit penetrations, sleeves, ducts, pipes or other openings to pass through joists, beams, column capitals or columns, except where indicated or approved by the Consultant.
 - .2 Where approved by the Consultant, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.
 - .3 Sleeves and openings greater than 100 x 100 mm (4" x 4") not indicated must be reviewed by the Consultant.
 - .4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain written approval of modifications from the Consultant before placing of concrete.
 - .5 Confirm locations and sizes of sleeves and openings shown on drawings.
 - .6 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.

- .4 Joints
 - .1 Refer to typical details and drawings notes for detailing and maximum spacing requirements.
 - .2 Construction joints:
 - .1 Formed slab: Locate joints near slab / beam / girder midspans unless a beam intersects a girder at this point. In that case offset the girder joint twice the beam width and provide additional shear reinforcement to the acceptance of the Consultant.
 - .2 Slabs on steel deck not supported by composite steel beams: Locate joints in slabs at centre of supports unless there are composite beams.
 - .3 Slabs on steel deck on composite steel beams: Locate joints parallel to purlins at middle of span of slabs and so that joints cross over girders near their supports. Locate construction joints parallel to girders at 1200mm (4'-0") from centre line of girders and so that these girders are not included in the earlier pour.
 - .4 Walls: locate joints with PVC waterstops at least 300mm (12") away from wall corners and wall intersections.
 - .3 Provide evenly spaced vertical control joints in walls.
 - .4 Provide expansion joints where shown on Structural Drawings. Remove all forming and filler material used during construction and provide clear space between structural elements equal to width specified.
 - .5 Provide construction gaps where shown on Structural Drawings.
- .5 Anchor rods:
 - .1 Set anchor rods to templates in co-ordination with appropriate trade prior to placing concrete.
 - .2 Locate each anchor rod group to within 6mm (1/4") of required location.
 - .3 Grout anchor rods in holes drilled after concrete has set only after receipt of written approval from the Consultant.
 - .1 Drilled holes: to adhesive manufacturers' recommendations.
 - .4 Protect anchor rod holes from water accumulations, snow and ice build-ups.
- .6 Drainage holes and weep holes:
 - .1 Form weep holes and drainage holes in accordance with Section 03 10 00 - Concrete Forming and Accessories. If wood forms are used, remove them after concrete has set.
 - .2 Install weep hole tubes and drains as indicated.
- .7 Dovetail anchor slots: in accordance with Section 04 05 00 - Common Work Results for Masonry.
 - .1 Install continuous vertical anchor slot to forms where masonry abuts concrete wall or columns.
 - .2 Install continuous vertical anchor slots at 800 mm (2'-6") on centre where concrete walls are masonry faced.

- .8 Grout under base plates using procedures in accordance with manufacturer's recommendations which result in 100 % contact over grouted area.
- .9 Water-stops:
 - .1 Install water-stops to provide continuous water seal.
 - .2 Do not distort or pierce water-stop in way as to hamper performance.
 - .3 Mechanical Water-stops
 - .1 Provide mechanical (PVC) water-stops for expansion, construction, and control joints in exterior walls, basement walls, retaining walls, slabs supporting earth, and at other locations shown on the Drawings.
 - .2 Do not displace reinforcement when installing water-stops.
 - .3 Use equipment to manufacturer's requirements to field splice water-stops.
 - .4 Tie water-stops rigidly in place.
 - .5 Use only straight head- sealed butt joints in field.
 - .6 Use factory welded corners and intersections unless otherwise approved by the Consultant.
 - .4 Krytonite water-stops:
 - .1 Provide Krytonite water-stops for all construction and temporary joints in exterior walls, basement walls, retaining walls, slabs supporting earth, and at other locations shown.
 - .2 Locate Krytonite water-stops 75 mm (3") from outside face of concrete to avoid spalling of concrete due to swelling pressure of bentonite.
 - .3 Butt strips together. Do not overlap.
 - .4 Fasten to concrete at 600mm (2'-0") maximum.
 - .5 See manufacturer's instructions and specifications
- .10 Joint fillers:
 - .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by the Consultant.
 - .2 When more than one piece is required for joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.
 - .3 Locate and form isolation, construction and expansion joints as indicated.
 - .4 Install joint filler.
 - .5 Use 12 mm (1/2") thick joint filler to separate slabs-on-grade from vertical surfaces and extend joint filler from bottom of slab to finished slab surface unless indicated otherwise.

3.3 PLACING CONCRETE

- .1 Place concrete in accordance with CSA A23.1.
- .2 Delivery and place concrete with minimum re-handling.
- .3 Do not overload forms.

- .4 Cast slabs with a top surface that is level or sloping as required by the Drawings. Allow for cambering where required. Set top of slab below finished floor level by the distance required for the type of applied finish.
- .5 Where cambered steel beams are used, ensure that slab thickness is as specified. Measure from top of steel to control thickness.
- .6 Construction Gaps:
 - .1 Do not fill beam and slab construction gaps until all concrete at that level is at least 28 days old.
 - .2 Do not fill wall construction gaps until all adjoining framed slabs, above and below, are at least 28 days old.

3.4 FINISHING

- .1 Finish concrete to CSA A23.1/A23.2.
 - .1 Architectural concrete: refer to the architectural specifications and drawings.
 - .2 Use procedures as noted in CSA A23.1/A23.2 to remove excess bleed water. Ensure surface is not damaged.
 - .3 Use curing compounds compatible with applied finish on concrete surfaces. Provide written declaration that compounds used are compatible.
 - .4 Finish concrete floor to CSA A23.1/A23.2. Class A.
- .2 Finishing Flatwork:
 - .1 See Section 03 35 00 - Concrete Floor Finishing.
 - .2 Protect concrete during finishing process. Use evaporation reducer during severe drying conditions.
 - .3 Provide final finish in accordance with proposed use and as follows:
 - .1 Screeded and bull floated for: mud slabs and footings/pile caps.
 - .2 Screeded and bull floated with scratch finish for: base slabs which receive mortar setting beds or bonded toppings.
 - .3 Powered float finish for: roofs (except future floors) and slabs which receive a membrane.
 - .4 Wood float finish with brooming for: exterior exposed slabs.
 - .5 Powered steel trowel finish for: interior exposed slabs, slabs which receive resilient flooring, carpet, epoxy-based finishes, thin-set tiles, etc. and future floors. Do not trowel air entrained concrete.
 - .6 Steel trowel exposed interior concrete floors at least twice. Provide final spin trowelling when non-slip finish is required.
 - .4 Concrete floor to have finish hardness equal to or greater than XXX Mohs hardness to CSA A23.1/A23.2.
 - .5 Surface hardeners:
 - .1 Provide where hardened concrete is required by Architectural Drawings or Specifications.

- .2 Use only liquid hardeners on air entrained concrete; do not use dry-shake applied surface hardeners.
 - .3 Incorporate hardener into the surface of the concrete while concrete is still plastic.
 - .4 Follow manufacturer's recommendations for dosage and application procedure.
 - .5 Where coloured hardeners are required, colour will be selected from available colours by Consultant.
 - .6 Hold pre-construction meeting with hardener technical representative and finisher to ensure proper application, curing and protection.
- .3 Finishing Formed Surfaces:
- .1 Completely fill holes left by through-bolts with grout.
 - .2 Do not patch surfaces until instructed in writing by Consultant.
 - .3 Concrete exposed to view:
 - .1 Provide smooth-form finish.
 - .2 Rub exposed sharp edges with carborundum to produce 3 mm (1/8") radius edges unless otherwise indicated.
 - .4 Architectural Concrete:
 - .1 Refer to Architectural drawings for concrete elements which are considered Architectural Concrete.
 - .2 Final appearance of architectural concrete is as important a factor as the engineering properties of the concrete and failure of the as-cast concrete to meet the required standard of appearance may be cause for rejection at the discretion of the Consultant.
 - .3 Do not patch surfaces unless instructed in writing by Consultant. All patches must match colour and texture of adjacent concrete to approval of Consultant.
 - .4 Provide smooth-form finish. Do not rub surfaces unless agreed to by Consultant.
- .4 Concrete exposed to view:
- .1 Exposed surfaces to be dense, even, uniform in colour, texture and distribution of exposed aggregate.
 - .2 Defects such as honeycombing, voids, loss of fines, visible flow lines, cold joints or excessive bug holes may be cause for rejection at the discretion of the Consultant.
- .5 Toppings:
- .1 Topping mixture to meet minimum requirements as follows: Bonded overlay of a thickness noted on the structural drawings.
 - .2 Make allowance for bonded overlay topping thickness when pouring base course.
 - .3 Apply cement/sand grout to base course to CSA A23.1/A23.2.

- .4 Place bonded topping to CSA A23.1/A23.2 and topping manufacturer's recommendations.
- .5 Ensure that joints in topping are of same material as those in base course. Also ensure that their locations precisely match those in base course.

3.5 SURFACE TOLERANCE

- .1 Concrete surface tolerance to CSA A23.1, Straightedge Method.
- .2 Finish concrete floor to CSA A23.1/A23.2. Class A.

3.6 CONCRETE CURING AND PROTECTION

- .1 At a minimum cure and protect concrete in accordance with CSA A23.1
- .2 Extend curing and protection period until concrete has reached following strength levels for structural safety:
 - .1 Framed slabs and beams: 75% of specified 28-day strength.
 - .2 Columns, walls, piers and footings: 50% of specified 28-day strength
- .3 For concrete containing supplementary cementing materials, curing and protection times may need to be extended beyond those outlined by CSA A23.1 to achieve the required structural properties.
- .4 Cure slab surfaces immediately after finishing is completed. Unless otherwise noted, use a curing compound compatible with applied finishes.
- .5 Do not use curing compound on parking garage slabs and where bonded topping is to be applied. Cover slab surfaces with absorptive mat or fabric and keep continuously wet.
- .6 Slabs on grade and structural slabs receiving resilient floor or other moisture sensitive finishes:
 - .1 Apply 24 hours of wet curing. Start curing immediately after finishing slab.
 - .2 Cover slab for at least 72 hours using plastic sheets with joints taped and free edges covered.
 - .3 Protect finished and cured slab from surface water (i.e. rain, snow).
 - .4 Refer to Architectural Specifications for required testing methods prior to placing floor finishes.
- .7 Concrete exposed to view:
 - .1 Protect during construction period from wear, damage, marking, discolouration, staining and becoming coated with concrete leakage.
 - .2 Unless rejected, repair damage and remove marks and stains to the approval of the Consultant.

3.7 SLABS ON GRADE

- .1 Construction joints and sawcut joints:
 - .1 Refer to drawing notes for maximum spacing requirements.
 - .2 Saw cut depth to be equal to one quarter of the concrete thickness.
 - .3 Locate joints on column lines wherever possible and on intermediate lines, which result in approximately square panels, without re-entrant corners.
 - .4 Do not create "L" shaped panels nor "T" shaped joint intersections.
 - .5 Protect edges of saw-cuts from breakage.
 - .6 Clean out saw-cuts in exposed concrete and fill with control joint filler after concrete is at least 120 days old.
 - .7 Sawcut top 25 mm (1") at construction joints in exposed concrete for a width of 5 mm (3/16") and fill with control joint filler after concrete is at least 120 days old.
 - .8 Clean out saw-cuts in other concrete and fill with a sand-cement paste one month prior to installing floor coverings.
- .2 Isolation Joints:
 - .1 Unless otherwise shown on structural drawings, provide min. 10mm (3/8") thick pre-moulded joint filler of the same depth as the thickness of the concrete wherever slabs-on-grade abut foundation walls, columns and piers. Omit if slab is chased or dowelled into structure.
 - .2 Furnish filler for each joint in single piece for depth and width required for joint,
 - .3 When more than one piece of filler is required for a joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.
- .3 Cracks in Slabs-on-Grade:
 - .1 Extensive cracking of slabs-on-grade or cracks in excess of 3mm (1/8") in width may be cause for rejection of slab or portion of slab at Consultant's discretion.
 - .2 Protect edges of cracks in slabs-on-grade from breakage.
 - .3 Exposed slab on grade: Unless slab is rejected, repair cracks that are over 0.4 mm (0.016") wide:
 - .1 Fill cracks with a sand-cement grout after concrete is at least 120 days old.
 - .2 Seven days later, cut out top 20 mm (3/4") of crack for a width of 5 mm (3/16") and fill with control joint filler.
 - .4 Architectural slab on grade: Unless slab is rejected, repair cracks that are over 0.2 mm (0.008") wide:
 - .1 Fill cracks with epoxy after concrete is at least 180 days old.
 - .2 Take all measures necessary to prevent epoxy on surface of exposed slab.
 - .3 Have manufacturer's technical representative present during initial repairs.

- .4 Steel fiber reinforced Sabs - on-Grade:
 - .1 Add steel fibre reinforcement on site after concrete slump test indicates that concrete slump is within specified limits.
 - .2 Use laser screed machine to screed concrete.
 - .3 Use magnets, or other means, to remove any surface fibres during finishing operations so that no fibres are left exposed on the surface.
 - .4 Use "Soff-Cut" saw to sawcut control joints.

3.8 FIELD QUALITY CONTROL

- .1 Site tests:
 - .1 Frequency and number of tests to be performed in accordance with CSA A23.1/A23.2.
 - .2 Conduct tests as follows and submit reports as described in Action and Informational Submittals.
 - .1 Concrete pours.
 - .2 Slump.
 - .3 Air content.
 - .4 Compressive strength at 7 and 28 days.
 - .5 Air and concrete temperature.
 - .6 Fresh density (for low or semi-low-density concrete).
 - .2 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory designated by the Consultant for review to CSA A23.1/A23.2.
 - .1 Ensure testing laboratory is certified to CSA A283.
 - .3 Ensure test results are promptly distributed to all associated parties including the Owner, Project Manager\Contractor and Consultant.
 - .4 Take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
 - .5 Non-Destructive Methods for Testing Concrete: to CSA A23.1/A23.2.
 - .6 Inspection or testing by the Consultant will not augment or replace Contractor quality control nor relieve Contractor of their contractual responsibility.
 - .7 Fresh density tests will be made on site for semi-low density, low density and high-density concrete. Assist the Agency to correlate fresh density with air-dry density prior to work beginning on site. Reports will include both fresh density and air-dry density.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for polished concrete work in accordance with the Contract Drawings.

1.2 **REFERENCES**

- .1 ACI 308.1, Specification for Curing Concrete.

1.3 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Two copies of manufacturer's Product data on characteristics, performance criteria, and limitations.
 - .2 Preparation, installation requirements and techniques, Product storage, and handling criteria.
- .2 Samples: Submit samples in accordance with Section 01 33 00 indicating coating and final concrete finish.
- .3 Reports: Submit manufacturer's acceptance of substrate prior to installation in writing. Submit verification of moisture content of floor prior to installation.
- .4 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.
- .5 Close-out submittals: Submit maintenance data for incorporation into Operations and Maintenance manuals in accordance with Section 01 78 00.

1.4 **QUALITY ASSURANCE**

- .1 Perform work of this Section by a company that has a minimum of five years proven experience in installations of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Mock-up:
 - .1 Construct one 3 m² mock-up of polished concrete in location acceptable to Consultant.
 - .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
 - .3 Mock-up may remain as part of Work if accepted by Consultant. If sealer application is unacceptable to Consultant, rework sealer in accordance with manufacturer's recommendations to provide a sealed concrete surface acceptable to Consultant.
 - .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

- .3 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, pour schedule and to review Mock-up and installation procedures 48 hours in advance of installation.

1.5 **SITE CONDITIONS**

- .1 Do not install the work of this Section outside of environmental ranges as recommended by the manufacturer without Product manufacturer's written acceptance and as follows:
 - .1 Relative Humidity: In accordance with manufacturers' requirements.
 - .2 When no dust is being raised.
 - .3 In well-ventilated and broom clean areas.
- .2 Install temporary protection and facilities to maintain the Product manufacturer's, and the above specification, environmental requirements for 24 hours before, during, and 24 h after installation.
- .3 Post do not enter and appropriate warning signs at conspicuous locations.

1.6 **DELIVERY, STORAGE, AND HANDLING**

- .1 Store materials at site in an area specifically set aside for purpose that is locked, ventilated, and maintained at a minimum temperature of 16°C.
- .2 Ensure that health and fire regulations are complied with in storage area, and during handling and application.

1.7 **EXTENDED WARRANTY**

- .1 At completion of this work, provide a signed Sealant and Waterproofing Association warranty to the Owner covering defects of workmanship and materials for a period of 2 years commencing from date of Ready-for-Takeover. Agree to make good promptly any defects which occur or become apparent within the warranty period in conjunction with the membrane manufacture's warranty. Defects shall include but not be limited to leakage, deformation and failure to stay in place. Coverage includes complete replacement including affected adjacent work at no cost to Owner.

2 **Products**

2.1 **MATERIALS**

- .1 General:
 - .1 All materials under work of this Section, including but not limited to, sealers and coatings are to have low VOC content limits.
 - .2 Each material used in the application of each flooring system shall be as recommended or manufactured by the supplier of the flooring system.

2. Polished concrete sealer (PCONC.1): Magnesium fluorosilicate concrete hardener and dustproofer; 'MasterKure HD 300WB' by Master Builders Solutions or approved alternative by W. R. Meadows.

3 Execution

3.1 EXAMINATION

- .1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify that concrete floor has cured 28 days minimum and that substrate was cured in accordance with ACI 308.1 and is acceptable to sealer manufacturer.
- .3 Test surfaces for moisture content to ensure that they are suitable for application.

3.2 APPLICATION

- .1 Apply minimum three coatings of sealer to entire surface in accordance with manufacturer's written instructions. Diluted ratio as recommended by manufacturer.
- .2 Apply first coat and allow floor to dry until no longer visibly wet.
- .3 Apply second coat and if crystals develop, flush surface liberally with clean water. At same time, rapidly brush floor with a stiff bristle broom. Mop up excess water and allow surface to dry.
- .4 Apply final coat and wait for uniform appearance of white crystals to appear while drying. Flood floor with water and lightly buff floor with a commercial floor buffer and non-aggressive pad to bring up patina/polish finish and until whiteness is gone.

3.3 CLEANING

- .1 Remove promptly as work progresses spilled or spattered materials from surfaces of work performed under other Sections. Clean floors on completion of work. Do not mar surfaces while removing.

3.4 PROTECTION

- .1 Erect barriers to prevent the entry and presence of personnel not performing work of this Section during application of floor sealer, and for 48 hours following completion of application.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for the precast concrete stairs work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A123, Specification for Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products.
- .2 ASTM A1064/A1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- .3 ASTM C920, Specification for Elastomeric Joint Sealants.
- .4 CAN/CSA-A23.1/A23.2, Concrete Materials & Methods of Concrete Construction / Methods of Test for Concrete.
- .5 CSA A23.4, Precast Concrete - Materials and Construction.
- .6 CAN/CSA G30.18-M, Billet-Steel Bars for Concrete Reinforcement.
- .7 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steels (Metric Version).
- .8 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
- .9 CSA W48, Carbon Steel Covered Electrodes for Shielded Metal Arc Welding.
- .10 CSA W59, Welded Steel Construction (Metal Arc Welding).
- .11 CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction.

1.3 **DESIGN REQUIREMENTS**

- .1 Design precast concrete stair elements, including anchors, connections and inserts, in accordance with CSA A23.4 and a minimum live load of 4.8 kN/m², dead load, lateral, and seismic loading, handling, transportation and erection loads, and imposed loads.
- .2 Design members and their connections to withstand, within acceptable deflection limitations as specified that part of the total deflection occurring after attachment of nonstructural elements (sum of the long-time deflection due to all sustained loads and the immediate deflection due to any additional live load); span/480.

- .3 Comply with the design and performance requirements of the building codes and as specified, follow profiles elevations and sizes shown on drawings, and design and engineer the work accordingly.
- .4 Design precast elements to withstand gravity, temperature and shrinkage stresses, and can safely transmit horizontal and vertical loads through anchor points.
- .5 Bearing areas to be reinforced against diagonal tension, splitting, rupturing and flexure. Place extra ties, stirrups and reinforcing bars at structural points. Do not allow bearing pressure to extend to edges of unreinforced sections.
- .6 Supporting structure for precast stairs may deflect due to various loadings imposed on it both initially and over the long term. Typical calculated predictions of the movements of the structure due to deflection will be provided at locations of the connections, if required. The magnitude of the loads is based on the configuration of the precast concrete members shown and the design criteria of the applicable building code.
- .7 Design anchor, reinforcing and other connection material required for the attachment of the precast stairs to the structure under this Section.
- .8 Anchors and connections shall be structurally stressed to not more than 50% of the allowable stress when maximum load conditions are applied.
- .9 Cast-in anchorages are part of the work of this Section. Provide these elements to the site on schedule to be incorporated into the Work.

1.4 **SUBMITTALS**

- .1 Shop drawings:
 - .1 Submit shop drawings of precast elements in accordance with Section 01 33 00.
 - .2 Submit shop drawings in accordance with CSA A23.4, including but not limited to the following:
 - .1 Location of each unit in the completed structure.
 - .2 Size and dimension of each stair.
 - .3 Anchors, inserts, and hardware setting / layout drawings.
 - .4 Tables and bending diagrams of reinforcing steel.
 - .5 Formwork, inserts, and associated reinforcement.
 - .6 Appurtenances for handling and erection.
 - .7 Concrete mix design.
 - .8 Concrete strength and admixtures.
 - .9 Connection details and erection procedure.

1.5 **QUALITY ASSURANCE**

- .1 Retain a Professional Engineer, licensed in the Province of Ontario and experience in precast concrete stair work of comparable complexity and scope, for the following services as part of the work of this Section:
 - .1 Design precast stairs to accommodate live, dead, lateral, seismic, handling, transportation, erection and other loads.
 - .2 Review, stamp, and sign fabrication and erection shop drawings, design calculations, and amendments thereto.
- .2 Engineer designing precast stairs shall be insured against professional liability in accordance with section 74 subsection (1) of Regulation 941 of the Ontario Professional Engineers Act. The alternative of compliance with subsection (2) is not acceptable.
- .3 Certification:
 - .1 Manufacturer/erector: CSA certification under CSA A23.4 for Category SC products.
 - .2 Prior to fabrication, submit certified copies of quality control tests as specified in CSA A23.4 for the following:
 - .1 Reinforcement, hardware, and connections.
 - .2 Concrete materials.
 - .3 Grout.
 - .4 Accessories.
 - .3 Mill test reports for steel reinforcement verifying conformance with CAN/CSA-G40.20/G40.21-M.
 - .4 Submit Product manufacturer's written certification that fabrication and erection of the precast structural concrete elements are in conformance with the Contract Documents.
- .4 Welding: Both shop and in the field, shall conform to CSA Standards W59-M and W186-M. Any organization undertaking to weld shall be fully approved by the Canadian Welding Bureau under the requirements of CSA W47.1.
- .5 Mock-Up:
 - .1 Construct on Site a typical sample installation of one set of precast stairs between floors in location designated by Consultant.
 - .2 Adjust sample installation as required to gain acceptance. Accepted work may form part of final installation. Work shall match accepted installation.

1.6 **DELIVERY, STORAGE, AND HANDLING**

- .1 Handle, transport, and store precast stairs as required by CSA A23.4 and by use of method, devised or approved, or both, by fabricator to prevent staining, soiling, and damage.
- .2 Store precast stairs to clear ground or other bearing surfaces, to prevent overstress, warp, twist, accumulation of water and snow in depressions and holes, and to afford free movement of air on all sides of each unit.

- .3 Deliver precast stairs to those who are responsible for installation to the place they direct, and to meet installation schedule.

2 Products

2.1 MATERIALS

- .1 Formwork: CSA A23.4.
- .2 Steel for reinforcement: CAN/CSA G30.18-M; Type 400W, billet steel bars, deformed.
- .3 Welded steel wire fabric: ASTM A1064/A1064M for smooth wire fabric and deformed wire fabric, resistance welded in size and spacing shown.
- .4 Inserts, anchorage plates, flush plates, connections and hardware: CAN/CSA G40.20/G40.21-M, Type 350W.
- .5 Welding materials: CSA W48.
- .6 Galvanizing: ASTM A123; hot dipped galvanizing with minimum zinc coating of 610 g/m².
- .7 Touch-up primer: Organic zinc rich primer.
- .8 Primer: CISC/CPMA 1-73a.
- .9 Cement, aggregates, water, admixtures: CSA A23.4 and CAN/CSA A23.1/23.2-M. Use same brands and source of cement and aggregate for entire project to ensure uniformity of coloration and other mix characteristics.
- .10 Non-shrink grout: Pre-mixed, flowable, non-shrink grout without aggregate fillers; 'NC Grout' by Euclid Chemical Company, 'SikaGrout-713' by Sika Canada Inc., or '588-10K' by W. R. Meadows.
- .11 Sealant: ASTM C920, Type S, Grade NS, Class 100/50; One-part, low-modulus, moisture-curing, silicone. 'Dowsil 790' by Dow Consumer Solutions; 'Spectrem 1' by Tremco, Colour: as selected by Consultant.

2.2 FABRICATION

- .1 Fabricate precast elements in accordance with CSA A23.4 and reviewed shop drawings.
- .2 Mark each precast element, on a face which will be concealed in the final assembly, with the casting date and an identification code corresponding to the shop drawing layout, in order to facilitate element identification and erection.

- .3 Fabricate and coordinate inserts, anchorage plates, flush plates, and hardware required to accommodate the Work. Supervise and verify insert layout during fabrication. Provide for items to be cast into concrete. Anchorage shall not interfere with reinforcement.
- .4 Formwork:
 - 1. Construct forms to maintain precast units within their specified tolerances.
 - 2. Secure attached anchorage devices to formwork in locations not affecting position of main reinforcement or placing of concrete.
- .5 Reinforcement: Reinforce work for in accordance with reviewed shop drawings. Weld reinforcement in accordance with CSA W186, finish with touch-up primer.
- .6 Provide concrete cover in accordance with CSA A23.4 and jurisdictional authorities. Minimum coverage shall not be less than 19 mm.
- .7 Concrete: Proportion normal density concrete in accordance with CAN/CSA A23.1/A23.2, to give following properties:
 - .1 Cement: use Type 10 Portland cement.
 - .2 Minimum compressive strength at 28 days: 35 MPa.
- .8 Consolidate concrete through full cross-section of units to provide full bond with reinforcement. Surfaces shall be free of cold joints and honeycombing and with cambers incorporated.
- .9 Finish treads of concrete stairs with non-slip finish. Treads to have raised non-slip continuous parallel ridges 50 mm wide near nosing. Raised portions to be 2.0 mm high, 2.0 mm wide and spaced 4.0 mm apart.
- .10 Finish risers and underside of stairs smooth. Provide 10 mm chamfer at junction of tread and riser.
- .11 Curing: Cure precast units in accordance with CSA A23.4, normal curing.

2.3 **SOURCE QUALITY CONTROL**

- .1 Fabrication Tolerances: Dimensions of finished work shall be within the following tolerances:
 - .1 Width or thickness, plus or minus 3 mm.
 - .2 Length, plus or minus 6 mm.
 - .3 Units not out of square more than 3 mm in 2 m, or 6 mm in over 2 m.
 - .4 Inserts, bolts, holes, etc., plus or minus 6 mm.
 - .5 Warpage not to exceed span divided by 360.
- .2 Inspection and Testing: Owner may engage an inspection and testing laboratory to test and report on materials and methods of fabrication of precast work.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Upon completion of precast structural concrete work and prior to grouting or concealing of connections, submit a letter of inspection from the precast concrete supplier's engineer stating that precast concrete work has been manufactured and erected in accordance with the Contract Documents.

3.2 **ERECTION**

- .1 Supply information required for installation of anchors, supports, inserts, and similar accessories that are required for work of this Section and are installed under work of other Sections. Assist or supervise, or both, in their installation.
- .2 Erect precast elements in accordance with CSA A23.4. Erect units without damage to shape or finish. Replace damaged units.
- .3 Fit and align precast concrete stairs straight, plumb, level, and square with uniform joint widths. Cumulative dimensional error in positioning precast units will not be allowed.
- .4 Ensure that building structure is adequately shored and supported to withstand loading imposed by erection procedures. Provide temporary blocking and bridging during erection to prevent movement of units in place.
- .5 Secure units in position by positive, mechanical connections in accordance with reviewed shop drawings and capable of maintaining loads which may be applied to the unit and allowing for structural deflections and building movements.
- .6 Supply and install welded and bolted connections in accordance with the design requirements. Weld to steel structures in accordance with CSA W59. Touch-up weld damage to protective coatings with galvanized touch-up primer. Secure bolts with lockwashers.
- .7 Provide required ULC/CSA approved grout/sealant to meet fire resistance ratings. Fill anchorage recesses and joints between precast stairs and adjoining construction with grout. Saturate surfaces of joints with water before grouting.
- .8 Clean field welds with wire brush and touch-up galvanized zinc-rich primer.
- .9 Do not install chipped, cracked, blemished, stained, or otherwise defective units.
- .10 Seal joints between precast units and adjoining construction in accordance with Section 07 92 00.

3.3 SITE TOLERANCES

- .1 Non-cumulative:
 - .1 Joint dimension: nominal 9 mm; to vary not more than 6 mm to 12 mm.
 - .2 Edge alignment and offset: not to exceed 3 mm.

3.4 PATCHING

- .1 Repair damaged and defective precast stairs which have not been rejected by the Consultant. Submit to the Consultant for approval, the method and materials to be used for repair work.
- .2 Finish patches to match precisely the colour and texture of adjacent area. Remove and repatch areas that do not match.
- .3 Secure patch to concrete surfaces with a bonding agent in accordance with manufacturer's directions.
- .4 Cut off lifting devices from precast units and patch recesses with grout.
- .5 Patch damaged painted surfaces with rust inhibiting paint.

3.5 CLEANING

- .1 Clean surfaces of work exposed to view after joint treatment is complete. Use fibre brushes, water, and mild cleaning agents only as recommended by precast fabricator. Remove deposits of foreign material, dirt, soil, and stains. Do not use tools which will damage finish surfaces. Rinse thoroughly with clean water after cleaning.
- .2 Protect adjoining work from damage during cleaning.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

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

1.2 **REFERENCES**

- .1 ASTM C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
- .2 ASTM C1708/1708M, Standard Test Method for Self-leveling Mortars Containing Hydraulic Cements.
- .3 ASTM C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Sections, details, materials, dimensions, thicknesses of each layer, maximum and minimum thicknesses, 3, 7, and 28 day load characteristics, and surface finishes
- .3 Certificates: Submit certification from manufacturer, stating that materials proposed for use are compatible with specified floor finishes.

1.4 **QUALITY ASSURANCE**

- .1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in installations of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Mock-up:
 - .1 Construct one room mock-up of topping in location acceptable to Consultant.
 - .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
 - .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

- .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

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 Concrete temperature: 10°C minimum.
 - .2 Ambient air temperature: 16°C to 30°C
 - .3 Precipitation: None.
 - .4 Relative Humidity: [If applicable].
- .2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 48 hours before, during, and 48 hours after installation.

2 Products

2.1 MATERIALS

- .1 Primer: Type as recommended by topping manufacturer to suit site conditions and intended end use.
- .2 Concrete based levelling compound (floor finish):
 - .1 Compressive strength to ASTM C1708/1708M, 28 day, 4300 psi.
 - .2 Flexural strength to ASTM C348: 28 day, min. 850 psi.
 - .3 Acceptable material: 'TechLevel 150' by CustomTech or approved alternative by Ardex Engineered Cements.
- .3 Concrete based levelling compound (exposed surface):
 - .1 Compressive strength to ASTM C109, 28 day, 6100 psi.
 - .2 Flexural strength to ASTM C348: 28 day, min. 1200 psi.
 - .3 Acceptable material: 'Ardex SD-T Self-Drying, Self-Levelling Concrete Topping' by Ardex Engineered Cements or approved alternative.
- .4 Concrete based levelling compound (interior application where flooring finish):
 - .1 Compressive strength to ASTM C1708/1708: 28 day 5500 psi.
 - .2 Flexural strength to ASTM C348: 28 day min. 1100 psi.
 - .3 Surface burning characteristics: ASTM E84: flame spread 0; fuel contribution 0; smoke development 0.
 - .4 Acceptable material: 'TechLevel XP-1' by CustomTech or approved alternative by Maxxon Corporation.
- .5 Water: potable.

2.2 **MIXES**

- .1 Mix toppings in accordance with manufacturer's written instructions.

3 Execution

3.1 **EXAMINATION**

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

3.2 **PREPARATION**

- .1 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.
- .2 Prohibit traffic on prepared areas until work of this Section is completed.
- .3 Supply and install temporary protection to adjacent surfaces, floor drains, and steel angles to prevent damage resulting from work of this Section.
- .4 Prior to application of topping, remove all debris by vacuuming.

3.3 **INSTALLATION**

- .1 Install cementitious topping in accordance with reviewed shop drawings and manufacturer's written instructions.
- .2 Self-leveling topping:
 - .1 Install topping material in accordance with manufacturer's instructions and as required to obtain overall thickness as indicated.
 - .2 Let cure in accordance with manufacturer's recommendations.
 - .3 Ensure smooth surface of topping, free of ridges or similar defects that would otherwise affect the application and final appearance of subsequently

3.4 **PROTECTION**

- .1 Provide temporary protection for surfaces subjected to concentrated loads before they have cured sufficiently to carry them without damage.
- .2 Prevent traffic over completed areas, and protect work of this Section from precipitation, freezing, and debris after final installation.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

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

1.2 **REFERENCES**

- .1 ASTM A580/A580M, Standard Specification for Stainless Steel Wire.
- .2 ASTM A1064/A1064-M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- .3 ASTM C207, Specification for Hydrated Lime for Masonry Purposes.
- .4 CAN/CSA A82, Fired Masonry Brick Made From Clay or Shale.
- .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 A3001, Cementitious Materials for Use in Concrete.
- .10 CSA G30.18, Carbon Steel Bars for Concrete Reinforcement.
- .11 CSA S304, Design of Masonry Structures.

1.3 **DESIGN REQUIREMENTS**

- .1 Design unit masonry in accordance with following Climatic Design Data for Toronto contained in the Ontario Building Code:
 - .1 Design temperature: January 1%, July 2 1/2%.
 - .2 Hourly wind pressures: 1 in 50 year occurrence.
 - .3 Seismic design: Class "C".

1.4 **SUBMITTALS**

- .1 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating.
 - .2 Wall sections and details, reinforcing and anchors, special detailing, patterning and locations of control joints.
 - .3 Seismic anchors, supports and accessories for complete installation.

- .2 Samples:
 - .1 Submit samples in accordance with Section 01 33 00:
 - .2 Submit samples of each type and colour of masonry unit used prior to placing order.
 - .3 Submit samples of coloured mortar to match masonry samples.
 - .4 Submit samples of masonry anchors, and ties.
 - .5 Submit 250 x 200 mm samples of dampproof course and flashing.
- .3 Quality control submittals: Submit manufacturer's certificates stating that materials supplied are in accordance with this Specification.

1.5 **QUALITY ASSURANCE**

- .1 Provide plain and reinforced masonry in accordance with CSA A370, CSA A371, and CSA S304.
- .2 Retain a licensed Professional Engineer, registered in Province of Ontario, to perform following services for unit masonry work:
 - .1 Design of unit masonry work.
 - .2 Design of brick ties and anchors, including requirements necessary to meet seismic requirements.
 - .3 Review, stamp and sign shop drawings.
 - .4 Conduct shop and field inspections and prepare and submit inspection reports.
- .3 Cold Weather Protection:
 - .1 To CAN/CSA-A371 and as follows:
 - .1 Maintain temperature of mortar between 5°C and 50°C until batch is used or becomes stable.
 - .2 Maintain ambient temperature of masonry work and it's constituent materials between 5°C and 50°C and protect site from windchill.
 - .3 Maintain temperature of masonry above 0°C for minimum of 3 days, after mortar is installed.
 - .4 Preheat unheated wall sections in enclosure for minimum 72 hours above 10°C, before applying mortar.
 - .5 Do not use scorched aggregate. Do not use salts or anti-freezes. Only use approved smokeless heaters.
- .4 Hot Weather Requirements:
 - .1 To CAN/CSA-A371 and as follows:
 - .1 Plan in advance for hot weather construction. Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.
 - .2 Avoid using dry masonry in hot weather conditions. Use predampened masonry unit nominally saturated, but surface dry at time of laying. Do not dip masonry unit in bucket of water.

- .3 Spread only enough mortar to permit soft setting of masonry units; do not over mix mortar materials; do not retemper mortar after 2 hours of use; do not retemper pigment coloured mortar; do not spread more than 900 mm (3') of mortar for placement of masonry unit.
- .5 Mock-up:
 - .1 Construct one mock-up panel of unit masonry construction, 1200 mm wide x 1800 mm high in a location accepted by Consultant.
 - .2 Demonstrate use of reinforcement, ties, through-wall flashing, weep holes, jointing, coursing, coping and sills, mortar, bonding, control joints, and workmanship.
 - .3 Mock-up may form part of Work if accepted by Consultant. Mock-ups which do not form part of Work are to be removed from Site during final cleanup, or when directed by Consultant.

1.6 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver, store and handle Products in accordance with the Conditions of the Contract and as specified herein.
- .2 Remove unacceptable materials from Site and replace to acceptance of Consultant. Store materials off ground protected from wetting by rain, snow or ground water, or inter-mixture with earth or other materials. Store metal ties and reinforcement to prevent corrosion.
- .3 Do not concentrate storage of materials on any part of structure beyond design load, take particular care not to overload unsupported portions of structure which may have not attained their full design strength.
- .4 Comply with CSA A371. Do not use salt or calcium-chloride to remove ice from masonry surfaces.
- .5 Deliver mortar materials in original unbroken and undamaged packages with the maker's name and brand distinctly marked thereon. Prevent damage to units.
- .6 Keep masonry materials free from ice and frost. Keep units protected from concrete, mortar and other materials which could cause staining.

2 Products

2.1 **MASONRY UNITS**

- .1 All Units Masonry work systems and components are to be provided by a single manufacturer to ensure a single source of responsibility for the Work of this Section.
- .2 Architectural brick (BR.1): CAN/CSA A82, Type X, Grade EG, metric modular, size as indicated; Manufactured by Canada Brick or by The Brick Industry or approved alternative. Brick type and colour to be selected by the Consultant.

- .3 Architectural brick (BR.3): CAN/CSA A82, Type X, Grade EG, metric modular, size as indicated; Manufactured by Glen Gery or approved alternate. Brick type to be selected by the Consultant. Colour: Custom colour to match Sterling Hall Blue.
- .4 Stone: 90 mm x 57 mm x 397 mm, Manufactured by Shouldice Stone or approved alternative. Stone type to be selected by the Consultant. Colour: Briar.
- .5 Architectural Block: Full split face, normalweight units, 90 mm thick unless otherwise indicated, sizes as indicated, CSA A165 Series; H/15/A/M; S/15/A/M; Sc/15/A/M; in colour to later selection by Consultant. Profiled concrete block to have profile on face and on exposed ends where special shapes are required. Manufactured by Canada Brick or by The Brick Industry or approved alternative.
- .6 Concrete block units: Lightweight units for use at all fire rated applications and block exposed to view, CSA A165 Series, sizes indicated on Contract Drawing, classifications as follows:
 - .1 H/15/D/M.
 - .2 SS/15/D/M.
 - .3 SF/15/D/M.
- .7 Concrete block units: Normalweight units for all non-fire rated applications and where concealed, CSA A165 Series, sizes indicated on Contract Drawing, classifications as follows:
 - .1 H/15/A/M.
 - .2 SS/15/A/M.
 - .3 SF/15/A/M.
- .8 Precast concrete sills and shapes: Reinforced and constructed of 27.5 MPa with slopes in direction indicated. Provide drips. Dowel and hook anchors to be stainless steel. Finish: Smooth unless otherwise indicated.
- .9 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.
- .10 Obtain each masonry unit type from same manufacturer. Supply and install units of uniform texture and colour for each kind required.
- .11 Supply masonry units with exposed surfaces free of cracks, chips, blemishes, and broken corners.

2.2 ACCESSORIES

- .1 Reinforcement: CSA A370, CSA A371, and ASTM A1064/A1064-M and ASTM A580/A580M, all components to be hot dip galvanized unless otherwise specified:
 - .1 This specification is based on products manufactured by Blok-Lok Limited. Products by Hohmann & Barnard Inc. and Fero Corporation are approved alternatives.
 - .2 Type 1 (single wythe): Truss type; 'Blok-Trus BL30'.
 - .3 Type 2 (double wythe): Truss type; 'Blok-Trus BL32'.
 - .4 Type 3 (cavity wall block back-up): Anchors fabricated from 1.5 mm plate with 4.76 mm wire, complete with screws; 'BL-507S Shear Anchor' with 'Flex-O-Lok tie'.
 - .5 Type 4 (cavity wall stud back-up): Anchors fabricated from 1.5 mm plate with 4.76 mm wire, complete with screws; 'BL607S Shear Anchor' with 'Flex-O-Lok tie'.
 - .6 Type 6 (cast-in-place back-up): Anchors fabricated from 1.5 mm plate x 50 mm wide with 25 mm bend with 4.76 mm wire, complete with screws; 'BL-5407' with 'Flex-O-Lok tie'.
 - .7 Connectors: CSA A370 and CSA S304.
 - .8 Reinforcing steel: CSA G30.18, Grade 400, refer to Contract Drawings for number, size, and location.
 - .9 Design of anchors, supports and accessories to meet seismic requirements.
- .2 Cavity wall insulation: In accordance with Section 07 21 00.
- .3 Loose steel lintels and lateral support angles: Supplied as part of work of Section 05 50 00.
- .4 Precast concrete shapes: Fabricate to shapes and sizes shown on drawings, 35 MPa concrete in accordance with CSA A23.4, galvanized steel reinforced. Dowel and hook anchors to be stainless steel.
- .5 Through wall flashings: prefinished metal flashings in accordance with Section 07 62 00, continuous strips with a 19 mm folded drip edge.
- .6 Dampproof course and flashing: Reinforced SBS rubberized asphalt compound laminated to cross-laminated polyethylene film, 40 mils thick; 'Blueskin TWF' by Henry or 'Airshield Thru Wall Flashing' by W.R. Meadows or approved alternative, complete with primer and adhesive recommended by flashing manufacturer.
- .7 Compressible filler: Approximately 75 mm x 80 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.
- .9 Mortar mesh: 250 mm high x thickness to suit cavity, 90% open HDPE mesh; 'Mortar Trap' by Blok-Lok Limited or 'Mortar Net' by Hohmann & Barnard, Inc.

- .10 Weep hole vents:
 - .1 Flexible ultra-violet resistant polypropylene-copolymer plastic, 'Cell-Vent' by Blok-Lok, 'Mortar Maze Cell Vents' by Advanced Building Products Inc. or approved alternative.
 - .2 Provide manufacturer recommended clear silicone adhesive for suspended applications.
 - .3 Colour: To be selected by the Consultant.

2.3 **MORTAR MATERIALS**

- .1 Loadbearing masonry: CSA A179, Type S, proportion method.
- .2 Interior non-loadbearing masonry: CSA A179, Type N, proportion method.
- .3 Exterior non-loadbearing masonry: CSA A179, Premixed 1-1-6 Type N, portland cement/lime, proportion method.
- .4 Cement: CAN/CSA A3001, normal Portland, Type GU. Provide white cement where required for white or light coloured mortars.
- .5 Masonry aggregate: CSA A179. Provide white aggregate where required for white or light coloured mortars.
- .6 Hydrated lime: ASTM C207, Type S.
- .7 Water: Clean potable, free from deleterious elements and free from salts that can cause efflorescence.
- .8 Mortar pigment: 'Bay Ferrox' by Bayer Inc. or approved alternative by Huntsman Pigments and Additives and Solomon Colors, Inc. Colour to later selection by Consultant.
- .9 Concrete fill and grout: Minimum 12.5 Mpa concrete in accordance with CSA A179.

3 Execution

3.1 **EXAMINATION**

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

3.2 **PROTECTION**

- .1 Supply and install temporary waterproof, non-staining coverings, secured against displacement, to extend over walls and down sides to protect masonry Work from snow and wind driven rain, and from drying too quickly, until masonry work is completed and protected by flashings or other permanent construction.

- .2 Supply and install non-staining, protective coverings on horizontal and vertical surfaces to protect work of this Section from damage, staining, marking, and mortar droppings.

3.3 **WORKMANSHIP**

- .1 Perform masonry work in accordance with CSA A371 and as indicated .
- .2 Supply and install masonry work plumb, level and true to line, with vertical joints in alignment and horizontal courses level, uniform, and straight.

3.4 **MASONRY - GENERAL INSTALLATION**

- .1 Construct masonry work as required by jurisdictional authorities.
- .2 Before commencing masonry work, verify required limitations for wall heights, wall thicknesses, openings, bond, anchorage, lateral support, and compressive strengths of masonry units and mortars.
- .3 Construct masonry fire protection and fire separations of the thickness indicated on Drawings for the fire resistant ratings as noted on Drawings, and conforming to the Fire-Performance Ratings, Appendix 'D' to the National Building Code of Canada.
- .4 Fire Separations and Fire Separations with Fire Resistance Ratings: Construct walls tightly to construction above and at perimeter, and without openings or voids. Do not reduce the thickness of walls to less than the thickness indicated on the Drawings or for the required fire resistance rating where required.
- .5 Do not butter corner units, throw mortar droppings into joints, or excessively furrow bed joints. Do not shift or tap units after mortar has taken initial set. If adjustment is necessary after mortar has started to set, remove and replace with fresh mortar.
- .6 Do not use admixtures without Consultant's written acceptance.
- .7 Tool mortar joints slightly concave with non-staining tools unless indicated otherwise. Strike joints flush in non exposed areas or where shown on Contract Drawings. Use sufficient force to press mortar tight against masonry units on both sides of joints. Remove excess, remaining mortar material and burrs.
- .8 Install masonry walls 25 mm clear of underside of steel building frames, roof or floor deck. Install masonry with a 19 mm space beneath shelf angles and install compressible filler.
- .9 Cut masonry units with a wet saw to obtain straight, clean, even, unchipped edges. Cut units as required to fit adjoining work neatly or for flush mounted electrical outlets, grilles, pipes, conduit, leaving 3 mm maximum clearance. Use full-size units without cutting wherever possible.

- .10 Reinforce veneer walls with adjustable wall reinforcing at maximum 400 mm o.c. vertically and 600 mm o.c. horizontally. Install reinforcing in accordance with manufacturer's instructions. In veneer walls extend reinforcement from support wall, spanning cavity into exterior wythe. Place at maximum 75 mm o.c. each way around perimeter of openings, within 300 mm of openings.
- .11 Reinforce block walls with continuous wire reinforcement in every second block course. Supply and install prefabricated L and T sections. Cut, bend and lap reinforcing units as per manufacturer's printed directions for continuity at returns, offsets, pipe enclosures, and other special conditions. Bending of masonry reinforcement is not permitted.
- .12 Reinforce masonry walls with reinforcing steel as indicated on Drawings. Vertical reinforcing shall be fully grouted in masonry cores with grout.
- .13 At openings in block walls install extra reinforcement, so that first and second courses above and below openings are reinforced. Extend extra reinforcement 600 mm beyond opening in each direction.
- .14 Reinforce joint corners and intersections with strap anchors 400 mm o.c.
- .15 Do not place reinforcement across masonry wythes at control joints.
- .16 Install masonry with 10 mm thick joints unless indicated otherwise. Make vertical and horizontal joints equal and of uniform thickness.
- .17 Build control joints in masonry walls at intervals and in locations shown. Form joints for block walls using sash block units in accordance with details shown. Form joints for veneer walls by leaving head joints between stacked units void of mortar. Fill chase and joint with joint filler full height of control joints. Leave a depth of 13 mm for sealing unless otherwise shown.
- .18 Install control joints in masonry walls where indicated on drawings and at projections and changes in direction. Where control joints have not been indicated provide joints at 6100 mm o.c. for exterior walls and 9150 mm o.c. for interior walls.
- .19 If required, provide movement joints, similar to building control joints, installed between areas with different support conditions.
- .20 Supply and install solid block or metal lath under block, and fill block cells solid for lintel bearing and as required to secure built-in anchor bolts and/or anchors shown.
- .21 Do not tooth intersections of walls except as otherwise indicated.
- .22 Install weep hole vents in accordance with manufacturer's directions, in exterior wythe of masonry above dampproof courses and flashings and at tops of walls using adhesive. Space weep hole vents maximum 600 mm o.c. horizontally. Prevent weep hole vents from becoming plugged with mortar or debris.

- .23 Coordinate installation of masonry with installation of air barrier and vapour retarder to ensure continuity of these systems.
- .24 Install seismic anchors, supports and accessories in accordance with reviewed shop drawings.

3.5 **DAMPPROOF COURSES AND FLASHING**

- .1 Install dampproof courses beneath first masonry bearing course on slabs-on-grade. Trim dampproofing to conceal it.
- .2 Install flashings in masonry in accordance with CSA A371.
- .3 Install flashings under exterior masonry bearing on foundation walls, slabs, shelf angles, and steel angles over openings and elsewhere as indicated. Where flashings occur over openings in walls extend them past openings a minimum of 200 mm and turn up minimum 150 mm at each end to create a waterproof dam to prevent water draining into cavity.
- .4 In veneer walls install flashings continuously from front edge of masonry, under outer wythe, turn up backing minimum 200 mm and provide watertight seal against support wall.
- .5 Lap dampproofing and flashing 150 mm and seal in accordance with manufacturer's instructions.
- .6 At bottom of cavity install mortar mesh to manufacturer's instructions. Apply additional mortar mesh layer as required to fill cavity thickness. Place mesh in continuous layer.
- .7 Before masonry work begins, place specified dampproofing under first course of masonry. Install continuous dampproofing with ends lapped and cut flush with exterior face of wall. Place similar dampproofing over top course.

3.6 **MORTAR MIXING**

- .1 Thoroughly mix mortar ingredients in proper quantities needed for immediate use to requirements of CSA A179.
- .2 Measure and batch mortar materials either by volume or weight, to accurately control and maintain proportions. Do not measure materials by shovel.
- .3 Mix mortar with maximum amount of water consistent with workability for maximum tensile bond strength within capacity of mortar.
- .4 Do not use mortar which has begun to set. Use mortar within 2 hours after initial mixing. Re-temper mortar during 2 hour period only as required to restore workability.
- .5 Add mortar colour and admixtures to requirements of manufacturer's instructions.

- .6 Provide uniformity of mix and colouration.

3.7 **BLOCK**

- .1 Lay blocks in running bond except as indicated otherwise. Align block webs vertically and install thicker ends of face shells up.
- .2 Install a full bed of mortar for first courses of masonry, for masonry units 100 mm thick and less, and between solid units. For remaining courses bed face shells, including vertical end joints, fully in mortar.
- .3 Install special shaped and sized concrete block units as indicated and as required for a complete and coordinated assembly and to minimize cut units.
- .4 Supply and install two courses of solid block beneath lintel bearing.
- .5 Stagger end joints in every course. Align joints plumb over each other in every other course.
- .6 Bond intersecting block walls in alternate courses. Where block work abuts concrete, anchor each block course to concrete.

3.8 **MASONRY VENEER**

- .1 Prior to installation of masonry veneer, coordinate installation of air and vapour retarder with Section 07 26 00.
- .2 Prior to installation of cavity insulation, examine air and vapour retarder and make good damage. Install cavity wall insulation in accordance with Section 07 21 00 .
- .3 Lay masonry veneer in running bond, unless indicated otherwise, and in a full bed of mortar.
- .4 Form angle corners with special shaped units; cutting of units is not permitted.
- .5 Erect exterior cavity wall construction as shown on Contract Drawings.
- .6 Install masonry veneer to prevent mortar droppings and protrusions from impeding drainage and pressure equalization of rainscreen cavities and drained walls.
- .7 Apply sufficient mortar on end of stretchers to ensure end joints are compressed full when masonry unit is pressed into place.

3.9 **PRECAST SHAPES**

- .1 Install dampproofing or flashings continuous under full length of precast shapes.
- .2 Install precast shapes in full mortar bed and secure units to each other with stainless steel dowels and to masonry units with stainless steel hook anchors, fully grouted.

3.10 LINTELS

- .1 Install concrete block lintels over openings in masonry except where steel lintels are indicated.
- .2 Set lintels with minimum of 200 mm uniformly distributed bearing at each end. Provide bond breaker under bearing ends.
- .3 Install reinforcing steel and concrete fill in block lintels.
- .4 Install loose steel lintels, as indicated in Contract Drawings. Centre over opening width.

3.11 LATERAL SUPPORT ANGLES

- .1 Where non load bearing unit masonry partitions meet structural elements at top of partitions, install supplied lateral supports as required by the Ontario Building Code and in accordance with Structural details. In areas where ceilings are scheduled, use 150 mm lengths of steel angle located each side of partition at 1200 mm and staggered.

3.12 BUILT-IN ITEMS

- .1 Coordinate and locate build-in items required to be built into masonry or supplied under work of other Sections including hollow metal doors, windows, lintels, sleeves, inserts, etc. Build-in items to present a neat, rigid, true and plumb installation.
- .2 Build wall openings, slots, and recesses required for ducts, grilles, pipes and other items.
- .3 Coordinate installation of conduit, outlet boxes and other mechanical and electrical built-ins with work of Divisions 21, 22, 23 and 26.
- .4 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as Work progresses.
- .5 Brace door jambs to maintain plumbness. Set anchors between metal frames and masonry and fill voids between hollow metal frames and masonry walls with mortar.

3.13 INSTALLATION TOLERANCES

- .1 Install masonry work to a plane flatness and exposed end tolerance of 3 mm in 3000 mm.
- .2 Variation in Alignment from Unit to Adjacent Unit: 1.5 mm maximum.
- .3 Plumb within 6 mm in 3 m, or in 6 mm in 6 m at external corners, expansion joints, or other conspicuous lines.
- .4 Level within 6 mm in any bay or 6 m maximum distance, and 12 mm in 12 m or more.

- .5 Located from position shown, and from related position of columns, walls, and partitions within 12 mm in any bay or 6 m maximum distance, and 19 mm in 12 m or more.
- .6 Opening sizes within 6 mm of designated dimension.
- .7 Column and wall cross-section dimensions within minus 6 mm and plus 12 mm.
- .8 Joint widths to dimensions indicated or specified herein, but in no case greater than 12 mm. Variation of Mortar Joint Thickness: 1 mm every metre.

3.14 **REPAIR AND POINTING**

- .1 Remove and replace masonry units which are loose, chipped, broken, cracked, marked, stained, discoloured, or otherwise damaged. Supply and install new units to match adjoining units and install in fresh mortar, and point to eliminate evidence of replacement.
- .2 During tooling of joints, enlarge any cracks, holes, or other defects, point and completely fill with mortar.
- .3 Point-up joints including corners, openings and adjacent Work for a neat, uniform appearance, properly prepared for application of sealant compounds.

3.15 **CLEANING**

- .1 Obtain and follow unit masonry manufacturer's written instructions for cleaning of masonry.
- .2 Clean exposed, masonry surfaces, removing excess mortar as work progresses. Allow mortar droppings to partially dry then dry brush with a stiff fibre brush.
- .3 Cleaning of stone work:
 - .1 Protect adjacent surfaces and other work from damage.
 - .2 Remove large particles with stiff fibre brushes without damaging surface. Saturate masonry with clean water and flush off loose mortar and dirt.
 - .3 Scrub with solution of 25 mL trisodium phosphate and 25 mL household detergent dissolved in 1 L of clean water using stiff fibre brushes, then clean off immediately with clean water using hose.
 - .4 Repeat cleaning process as often as necessary to remove mortar and other stains.

END OF SECTION

1 General

1.1 **RELATED REQUIREMENTS**

- .1 Section 03 30 00 – Cast-In-Place Concrete.
- .2 Section 05 31 00 – Steel Decking.
- .3 Section 05 50 00 – Metal Fabrications.
- .4 Section 07 81 00 – Applied Fireproofing.
- .5 Section 09 91 00 – Painting.
- .6 Section 09 91 23 - Interior Painting

1.2 **REFERENCES**

- .1 All referenced standards shall be the current edition, or the edition referenced by the Ontario Building Code in force at the time of building permit application.
- .2 Canadian Standards Association (CSA International):
 - .1 CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CAN/CSA-S16, Limit States Design of Steel Structures.
 - .3 CAN/CSA-S136, North American Specifications for the Design of Cold Formed Steel Structural Members.
 - .4 CSA W47.1, Certification of Companies for Fusion Welding of Steel.
 - .5 CSA W48, Filler Metals and Allied Materials for Metal Arc Welding.
 - .6 CSA W55.3, Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.
 - .7 CSA W59, Welded Steel Construction (Metal Arc Welding).
- .3 American Society for Testing and Materials (ASTM International):
 - .1 ASTM A36/A36M, Standard Specification for Carbon Structural Steel.
 - .2 ASTM A123 Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
 - .3 ASTM A193/A193M, Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature or High-Pressure Service and Other Special Purpose Applications.
 - .4 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .5 ASTM A992, Standard Specifications for Structural Steel Shapes.
 - .6 ASTM D6386, Preparation of Zinc (Hot-Dipped Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

- .7 ASTM F1554, Standard Specification for Anchor Bolts, Steel 36, 55 and 105 ksi Yield Strength.
- .8 ASTM F3125M, Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
- .4 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-85.10- [99], Protective Coatings for Metals.
- .5 Canadian Institute of Steel Construction (CISC)/Canadian Paint Manufacturers Association (CPMA):
 - .1 Handbook of the Canadian Institute of Steel Construction.
 - .2 CISC/CPMA Standard 1-73a, A Quick-drying One-coat Paint for Use on Structural Steel.
 - .3 CISC/CPMA Standard 2-75, Quick-drying Primer for Use on Structural Steel.
 - .4 CISC Code of Standard Practice, Appendix I, Architecturally Exposed Structural Steel (AESS).
- .6 Master Painters Institute:
 - .1 MPI-INT 5.1, Structural Steel and Metal Fabrications.
 - .2 MPI-EXT 5.1, Structural Steel and Metal Fabrications.
- .7 The Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE) International:
 - .1 SSPC-SP 1, Solvent Cleaning.
 - .2 NACE No. 3 / SSPC-SP 6, Commercial Blast Cleaning.
 - .3 NACE No.4 / SSPC-SP 7, Brush Off Blast Cleaning.
 - .4 NACE No.2 / SSPC-SP 10, Near White Blast Cleaning.
 - .5 SSPC Technology Guide No.14 – Guide for the Repair of Imperfections in Galvanized, Organic or Inorganic Zinc-Coated Steel Using Organic Zinc Rich Coating.
 - .6 SSPC Paint Specification No. 20 – Zinc Rich Coating

1.3 QUALITY ASSURANCE

- .1 In accordance with Section 01 43 00 – Quality Assurance.
- .2 Qualifications
 - .1 Structural steel fabricator to be a certified member of the Canadian Institute of Steel Construction and to have at least five years experience with structural steel for buildings.

- .2 Structural steel fabricator to be certified by the Canadian Welding Bureau under the requirements of CSA W47.1, Division 1 or 2 for fusion welding and/or CSA W55.3 for resistance welding of structural steel components.
- .3 Welders to be CWB approved, working under supervision of a CWB approved firm.
- .4 Engage a Professional Engineer licensed and insured in the Province of Ontario to be responsible for design, detailing and installation of all connections related to structural steelwork.
- .5 The Professional Engineer designing connections to hold a Certificate of Authorization, and to carry the minimum liability insurance (per occurrence) as required by PEO.

1.4 **QUALITY CONTROL**

- .1 Submit in accordance with Section 01 45 00 – Quality Control.
- .2 Source Quality Control Submittals:
 - .1 Submit mill test reports 4 weeks prior to fabrication of structural steel.
 - .1 Mill test reports to show chemical and physical properties and other details of steel to be incorporated in project and show compliance with the required standards.
 - .2 The reports to be correlated to the materials or products to which they pertain.
 - .3 Indicate traceability as to the origin of the steel manufacturer. All structural steel (including bolts) shall be produced in Canada, the US or EU countries.
 - .2 Provide structural steel fabricator's affidavit stating that materials and products used in fabrication are produced from the specified locations and conform to applicable material and products standards specified and indicated.
- .3 Tolerances
 - .1 Conform to the fabrication and erection tolerances of CAN/CSA S16.
 - .2 If more stringent tolerances are specified elsewhere to suit interfacing materials or AESS members, the latter shall govern.
- .4 On completion of erection, submit a letter signed and sealed by the Professional Engineer responsible for structural steel connections certifying that the work has been completed in accordance with all contract documents.

1.5 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

- .2 Submit 4 hard copies or unlocked PDF documents to the Consultant for review at least 4 weeks prior to fabrication and/or delivery.
- .3 Erection drawings:
 - .1 Submit erection drawings indicating details and information necessary for assembly and erection purposes including a description of methods; Sequence of erection; type of equipment used in erection, temporary bracings, beam sizes (in addition to beam marks), and AESS members and their category, and assembly finishing details
 - .2 It is recommended that erection diagrams are submitted for review prior to preparing shop details. Copies of the original structural drawings will not be accepted as erection diagrams.
- .4 Fabrication drawings:
 - .1 Submit fabrication drawings showing designed assemblies, components and connections are stamped and signed by qualified professional engineer licensed in the Province of Ontario, Canada. Indicate the following on the drawings:
 - .1 Material specifications.
 - .2 Surface preparation.
 - .3 Shop painting / galvanizing
 - .4 Section splices.
 - .5 Types of shop and field connections.
 - .6 Net weld lengths.
 - .7 Precautions which will be taken to exclude threads from shear planes of bearing type bolted connections (where applicable).
 - .8 Protected zones.
 - .9 Vent holes required for galvanizing process.
 - .2 Indicate members which are considered AESS, and their category. Refer to AESS Category Matrix as shown in Table 1 of the CISC Code of Standard Practice, Appendix I.
 - .1 For AESS welded connections, show grinding, profile and weld finish.
 - .3 Show details by which steel assemblies, which are set in concrete, are to be connected to the formwork.
 - .4 Substitution of alternative sections will only be allowed provided the new members have equal or greater capacity and stiffness and their dimensions are approved by the Consultant.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials in manufacturer's original, undamaged containers with identification labels intact.

2 Products

2.1 DESIGN REQUIREMENTS

- .1 Design details and connections in accordance with requirements of CAN/CSA-S16 and CAN/CSA-S136 with CSA-S136.1 to resist forces, moments, and shears and to allow for movements indicated. Include loads effects on the members and connections for loads due to fabrication, erection, and handling.
- .2 Shear connections:
 - .1 Select framed beam shear connections from an industry accepted publication such as "Handbook of the Canadian Institute of Steel Construction" when connection for shear only (standard connection) is required.
 - .2 Select or design connections to support the reaction resulting from the maximum uniformly distributed load that can be safely supported by beam in bending, provided no point loads act on beam, when shears are not indicated.
- .3 Submit sketches and design calculations stamped and signed by qualified professional engineer licensed in Province of Ontario, Canada for non-standard connections when requested.
- .4 Provide seated beam connections with top clip angles.
- .5 Provide all spandrel beams and all floor beams not fully braced by floor construction with top and bottom flange connections for torsional restraint.
- .6 Assume that bolt threads are intercepted by shear plane, unless special measures are indicated on shop drawings to exclude threads from shear plane.
- .7 Connection design to include consideration of all pass-through forces, including tension, compression, moment or shear. Provide local reinforcement at connection or joint as required.
- .8 Where axial forces occur in beams framing to opposite sides of a supporting member, design connections for a pass-through force equal to the smaller axial force. If beam sizes differ, assume the axial force is centred in the smaller beam. Where beams frame into columns, connect each beam for the axial force shown.
- .9 Follow conceptual connection details if shown on structural drawings. Do not change without the Consultant's written approval.
- .10 Pretension all high-strength bolts used in:
 - .1 All elements resisting crane loads.

- .2 Connections where bolts are subject to tensile loads.
- .3 Connections using oversized or slotted holes unless finger-tight bolts are required to accommodate movement.
- .4 Connections required by CSA S16 to be pre-tensioned.
- .11 Install web and flange stiffener plates at moment connections as required by connection design and detail, as well as when indicated on the drawings. If the shear generated in column web exceeds its shear capacity, reinforce the web.
- .12 For beams continuous over support, provide at least one stiffener plate each side of web, unless different stiffeners are shown on drawings.
- .13 Design gusset plates and bracing connections for members which are parts of seismic force resisting system to allow ductile rotation and to satisfy requirements of CSA S16. Design gusset plates for other compression members for the force equivalent to twice the specified compression member force or provide stiffeners to prevent gusset plate buckling.
- .14 Provide moment connections at splices to maintain continuity of cranked beams. Provide header plates or stiffener plates to resist unbalanced flange forces at splices.
- .15 Provide all wall supporting members (shelf angles, hangers, stubs, back braces, etc.) which are attached to floor beams with adjustable connections capable to compensate for the deflection of the floor beams due to self weight of concrete. Anticipate beam deflection to be equivalent to the camber shown, or 20 mm (whichever is more). Alternatively, fabricate based on actual deflected shape of the beams as measured after concrete is poured.
- .16 Detail and erect vertical diagonal plate and rod bracings to provide a prestress of approximately 15 MPa (2 ksi). Prestress to be effective when building ambient temperature has stabilized.
- .17 Provide slotted holes long enough to allow for deflection indicated on drawings plus construction tolerance, assuming bolts are centred in slots. Bolts are to be finger-tight with burred threads to allow for movement during the life of structure without bolts loosening.
- .18 Do not oversize anchor rod holes for site tolerances.
- .19 Connect new steel members to existing concrete using drilled concrete anchors. Activate wedge type anchors by applying pre-determined torque recommended by the manufacturer. Do not field weld at connections with adhesive anchors.

2.2 MATERIALS

- .1 Structural steel: to CSA-G40.20/G40.21 except:
 - .1 Hollow structural sections: to ASTM A500 or CSA G40.21.
 - .2 Structural pipe: to ASTM A53.
- .2 Anchor rods: to CSA-G40.20/G40.21, Grade 300W.

- .3 Bolts, nuts and washers: to ASTM F3125, grade A325/ASTM A325M type 1.
- .4 Welding materials: to CSA W48 Series, CSA W59 and certified by Canadian Welding Bureau.
- .5 Shop paint: to CISC/CPMA 1-73a.
- .6 Shop paint primer: to CISC/CPMA2-75 solvent reducible alkyd, grey. Primer is to be compatible with final paint or coating.
- .7 Headed Shear studs: to CSA W59, Appendix H Min. $F_y=350$ MPa Type B.
- .8 Joint filler for exposed steelwork: Epoxy resin.
- .9 Sliding bearing assembly: Galvanized top steel plate with a type 304 stainless steel highly polished lower surface and bottom elastomeric pad with a polytetrafluoroethylene (Teflon) upper surface. Static and kinetic coefficients of friction not to exceed 5% under 7MPa to 14MPa working stress. Elastomeric bottom pad to allow a 2% rotation of upper plate and still maintain a substantially uniform bearing pressure between plate and pad.
- .10 Elastomeric bearing pad: Structural grade 50 durometer neoprene.

2.3 FABRICATION

- .1 Fabricate structural steel in accordance with CAN/CSA-S16 and in accordance with reviewed shop drawings.
- .2 Install headed shear studs in accordance with CSA W59.
- .3 Continuously seal members by intermittent welds and plastic filler unless continuous welds are indicated on the drawings.
- .4 Weld threaded studs to structural steel members for attachment of wood nailers.
- .5 Position beams having permissible mill camber so that the camber is up.
- .6 Install stud anchors in shop with end welds in accordance with the recommendations of the stud manufacturer. Lengths of studs given on drawings are the lengths after welding. Replace studs that crack in the weld or shank.
- .7 Increase specified section thickness at no extra cost if required for fabrication (bending) or galvanizing, Alternatively, fabricate curved sections from plates.
- .8 Reinforce holes through webs of beams and columns in accordance with Typical Detail. Alternatively, design reinforcing in accordance with the procedure set forth in the CISC Handbook of Steel Construction, and provide calculations for the Consultant's review.
- .9 Provide 16mm (5/8") diameter weep holes in base plates of HSS columns which are not made watertight.
- .10 HSS members which require galvanizing to either be per CSA G40.21, grade 350W, Class H, or to be stress relieved prior to galvanizing.

- .11 Provide vent holes in HSS sections where required for galvanizing process. Located so that any water inside HSS will drain away when HSS is in its final position. Maximum size – 16mm (5/8") diameter. Fill holes with vent hole plugs after galvanizing.
- .12 Provide 12 (1/2") dia. holes in HSS columns to be filled with concrete. Locate at opposing column faces 150mm (6") from each end.
- .13 Connect together double beams and double channels in bending at not more than 1200mm (4 ft) centres unless the members are welded toe to toe.
- .14 Connect together axially loaded built-up members (including double angles and other built-up sections noted on the drawings) in accordance with the requirements of CSA S16. Unless otherwise noted on the drawings, connect built up members with the longest side back-to-back with a member spacing of 10mm. In addition, interconnect compression members for trusses and bracing at least at the one-third points.
- .15 Connect cover plates of built-up members to develop the capacity of the built-up member.
- .16 Weld beams to bearing plates unless otherwise noted on drawings. Extend beams for full length of bearing plates. Set bearing plates 10mm (3/8") back from edge of support.
- .17 Anchor roof beams bearing on walls with a minimum of two 16mm (5/8") diameter x 380mm (1'-3") long anchor rods, unless otherwise noted on the Drawings.
- .18 Provide cap plates at tops of columns where required for support of deck, slab, joists, beams or safety anchors.
- .19 Provide connections between tie joists and columns, coordinate with joist supplier.
- .20 Provide closure plates for all exposed and for all exterior tubular members.
- .21 Provide diagonal or cantilevered angles at sides of columns where required to support deck or slab.
- .22 Connect steel lintels to columns where openings are adjacent to columns.
- .23 Unless otherwise noted on drawings, provide 76 x 76 x 9.5 (3" x 3" x 3/8") seat angles attached to sides of columns to support masonry lintels adjacent to columns. Length of seat to equal width of lintel minus 25 mm (1").
- .24 Complete welded shop connections prior to galvanizing.
- .25 Where shop inspection is required, do not ship material to the site before it has been inspected.
- .26 Fabricate in stages complex members for which steel inspection is impossible or difficult once completed and arrange for the Inspection and Testing Agency to do intermediate shop inspections.
- .27 Fabricate AESS with tolerances and surface quality consistent with AESS category.

- .1 Clean, prepare surfaces, and shop paint or prime structural steel in accordance with CAN/CSA-S16.
- .2 Clean members, remove loose mill scale, rust, oil, dirt and foreign matter. Prepare surface according to SSPC-SP-1, Solvent Cleaning, except:
 - .1 Members receiving shop primer paint: Clean steel to SSPC-SP 7 Brush-Off Blast Cleaning.
 - .2 Members receiving intumescent coating: Clean steel to SSPC-SP 6 Commercial Blast Cleaning
 - .3 Members to receive zinc-rich coating: Prepare surface according to SSPC-SP-10, near white blast cleaning.
 - .4 Galvanized members to receive a finish coat of paint: ASTM D6386
- .3 Apply one coat of CISC/CPMA 1-73a shop paint to steel surfaces, except:
 - .1 Members to receive a finish coat of paint on site for which a CISC/CPMA 2-75 shop primer is required.
 - .2 Surfaces to be encased in concrete or in contact with concrete (such as tops of beams supporting slabs).
 - .3 Members to receive spray fireproofing.
 - .4 Surfaces to receive field installed stud shear connections.
 - .5 Surfaces and edges to be field welded.
 - .6 Faying surfaces of slip-critical connections.
 - .7 Members to be hot-dipped galvanized.
 - .8 Surfaces to receive zinc-rich coating.
 - .9 Surfaces to receive intumescent coating for which a compatible shop primer is required.
- .4 Apply one coat of compatible primer paint (CISC/CPMA 2-75) in the shop to steelwork to receive a finish coat of paint on site. Primer to be compatible with final paint or coating.
- .5 Apply one coat of compatible primer paint in the shop for steel to receive intumescent coating on site, see section 07 81 00 Applied Fireproofing. Primer to be compatible with final paint or coating.
- .6 Apply one coat of contrasting colour shop paint to all protected zones indicated on structural drawings to clearly delineate their extent.
- .7 Apply paint under cover, on dry surfaces when surfaces and air temperatures are above 5 degrees C.
- .8 Maintain dry condition and 5 degrees C minimum temperature until paint is thoroughly dry.
- .9 Strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.

3.1 APPLICATION

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

3.2 GENERAL

- .1 Structural steel work: in accordance with CAN/CSA-S16.
- .2 Welding: in accordance with CSA W59.
- .3 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel structures and/or CSA W55.3 for resistance welding of structural components.

3.3 CONNECTION TO EXISTING WORK

- .1 Verify dimensions and condition of existing work, report discrepancies and potential problem areas to the Consultant for direction before commencing fabrication.

MARKING

- .1 Mark materials in accordance with CSA G40.20/G40.21. Do not use die stamping. When steel is to be left in an unpainted condition, place the markings at locations not visible from the exterior after erection.
- .2 Match marking: shop mark for fit and match.

3.5 ERECTION

- .1 Erect structural steel, as indicated and in accordance with CAN/CSA-S16 and in accordance with reviewed erection drawings.
- .2 The structural drawings show the final intent of the steel structure. The Contractor is responsible to maintain adequate temporary bracing as necessary to keep the structure stable and in good alignment during construction. Do not overload the structure during construction.
 - .1 Temporary erection bracing is to be designed by a qualified professional engineer licensed in Province of Ontario, Canada retained by the Contractor.
- .3 Field cutting or altering structural members: Obtain approval of the Consultant prior to any modification.
- .4 Environmental considerations:
 - .1 Preheat material adjacent to welding areas when ambient temperature is between +4 degrees C and -17 degrees C.
 - .2 Do not weld in ambient temperatures below -17 degrees C.
- .5 Clean with mechanical brush and touch up shop primer to bolts, rivets, welds and burned or scratched surfaces at completion of erection.

- .6 Continuously seal members by continuous welds where indicated. Grind smooth.
- .7 Set column base plates on leveling screws or on steel shims to the required elevation ready for grouting. Alternatively, use leveling plates set with grout and level to within 1.5 mm (1/16") across the plate. Do not erect columns upon plates exceeding this tolerance. Lift base plates for inspection when directed.
- .8 Grout under column base plates and beam bearing plates as soon as steelwork is completed. Do not add load on steelwork until grouting is completed and grout strength has reached at least 20 MPa.
- .9 Do not make permanent connections until structure has been properly aligned.
- .10 Adjust and finalize connections at wall supporting elements affected by floor beam deflections after concrete is poured.
- .11 Report ill-fitting connections to the Consultant before taking corrective measures.
- .12 When welding after galvanizing is in place, grind away galvanizing at areas to be welded.
- .13 Do not weld in an ambient temperature below -17°C. Preheat material adjacent to welding areas when ambient temperature is between -17°C and +4°C.
- .14 Do not weld or otherwise attach any structural or non structural elements to protected zones unless noted specifically on structural drawings or reviewed and approved by the structural engineer. Failure to comply will result in full replacement of the affected members.
- .15 Remove slag from all completed welds so that they may be visually inspected.
- .16 Seal members by continuous welds where indicated.

3.6 FIELD QUALITY CONTROL

- .1 Inspection and testing of materials and workmanship, including visual third-party welding inspection, will be carried out by the testing agency as designated requirements in section 01 45 00 – Quality Control.
 - .1 Ensure testing agency is certified to CSA W178.1.
 - .2 Ensure individuals performing visual inspection of welds are certified to Level 2 or 3 of CSA W178.2.
 - .3 Do not commence fabrication until details of the inspection program have been coordinated with the Agency.
 - .4 Provide safe access and working areas for testing on site, as required by testing agency.
- .2 Arrange for the testing agency to be present during welding of 10% of moment connections and butt welds in direct tension (minimum 2 of each type).
- .3 Ensure test results are promptly distributed to all associated parties including the Owner, Project Manager\Contractor and Consultant.

- .4 Test shear studs in accordance with CSA W59.
- .5 Inspection or testing by the Consultant will not augment or replace Contractor quality control nor relieve Contractor of their contractual responsibility.
 - .1 Work will be inspected in the shop and when erected. Store fabricated members in the shop so that they are accessible for inspection. Items to be cast into concrete will be inspected on site before being installed.
 - .2 Inspection will include:
 - .1 Checking that the mill test certificates or producer's certificates are properly correlated to materials and products supplied for the project or that legible markings were made on the material and products by the producers in accordance with the applicable standards. Where this is not possible, notify the Consultant and if requested carry out sample tests as described below.
 - .2 Confirming that all materials meet specifications.
 - .3 Sampling fabrication and erection procedures for general conformity with the requirements of the Contract.
 - .4 Checking welders' CWB Certification.
 - .5 Checking fabricated members against specified member shapes.
 - .6 Checking fabricated members against allowable mill sweep and camber.
 - .7 Checking fabricated members against specified camber.
 - .8 Visual inspection of all welded connections including spot checking of joint preparation and fit up.
 - .9 Sample checking bolted joints.
 - .10 Sample checking stud anchors.
 - .11 Sample checking drilled concrete and masonry anchors.
 - .12 Sample checking that tolerances are not exceeded during erection including fit-up of field welded joints.
 - .13 Inspection of field cutting.
 - .14 Inspection of sliding bearings.
 - .15 Inspection of surface preparation, shop paint and field touch-up.
 - .16 Inspection of galvanizing and field touch-up.
 - .17 Inspection of grouting under base plates and bearing plates.
 - .3 Arrange for the Inspector to be present during welding of 15% of moment connections and 15% of butt welds in direct tension.
 - .4 Sample testing: When required, test coupons will be taken and tested in accordance with CSA G40.20 to establish identification. Cut samples from member locations selected by Structural Engineer and provide to the Inspection and Testing Agency. Make good the locations if requested, at no extra cost, by adding new plates and welds acceptable to the Structural Engineer. The Agency

- will have the samples tested for mechanical properties and for chemical composition and will classify the steel as to specification.
- .5 Arrange for the Inspector to start field inspection as soon as each section of the Work is completed, plumbed, bolts tightened, and field welding finished.
 - .6 The Inspector will check the specified camber of all beams. Do not place steel deck until this has been done and approved in writing by the inspector.
 - .7 The Inspector will undertake non-destructive weld testing of a representative 10% of welded connections and of all butt welds in direct tension. Results will be evaluated in accordance with CSA W59.
 - .8 The Inspector will visually check all bolts in bearing connections. Where erection drawings indicate bolts with threads excluded from the shear plane, he will remove nuts from 1% of all bearing bolts and check that thread is excluded from the shear planes.
 - .9 The Inspector will visually check all stud shear connectors on composite steel beams. At least one stud in every 150 and all studs which do not have a complete end weld, which are repaired by welding, or which show less than the normal reduction in height due to welding will be bent 15 degrees from their axis towards the nearest support, as specified in CSA-W59. Bent studs that show no sign of failure will be accepted and shall remain in the bent position. Studs that crack in weld, base metal or shank will be rejected. Studs with end welds covering less than 85% of the perimeter will be rejected even if they pass the bend test.
 - .10 The Inspector will provide full time inspection during installation of post installed adhesive anchors subject to sustained tension loads.
 - .11 The Inspector will randomly select and pull test 5% of all types and sizes of post installed anchors installed on a weekly basis, but not less than one anchor of each type, size and orientation. Pull test to twice the allowable tensile load, or 1.5 times the factored resistance of the anchor given by the manufacturer. Chose anchor locations where proximity to concrete edge does not affect anchor capacity, or use reduced anchor loads per manufacturer's recommendation. Submit reports to Consultant within one week of testing. Reports to indicate each anchor location, test load and mode of failure, if applicable. Notify Consultant immediately if any anchor fails the pull test.
 - .12 The Inspector will visually check all the adjustable connections at wall supporting members to ensure the connections have been finalized after the concrete is poured.

3.7 **FIELD PAINTING**

- .1 Paint in accordance with Section 09 91 23 - Interior Painting.
 - .1 Touch up damaged surfaces and surfaces without shop coat with primer to match original coating.
 - .2 Repair any galvanized or zinc rich painted surfaces which have been damaged, or field welded in accordance with the SSPC Technology Guide No. 14.

END OF SECTION

1 General

1.1 **RELATED REQUIREMENTS**

- .1 Section 03 20 00 – Concrete Reinforcing.
- .2 Section 03 30 00 – Cast-In-Place Concrete.
- .3 Section 05 12 23 – Structural Steel for Buildings.
- .4 Section 07 81 00 – Applied Fireproofing.
- .5 Section 09 91 00 – Painting.

1.2 **REFERENCES**

- .1 All referenced standards shall be the current edition or the edition referenced by the Ontario Building Code in force at the time of building permit application.
- .2 Canadian Standards Association (CSA International):
 - .1 CSA C22.2 No.79, Cellular Metal and Cellular Concrete Floor Raceways and Fittings.
 - .2 CSA S16, Design of Steel Structures.
 - .3 CSA S136, North American Specification for the Design of Cold Formed Steel Structural Members.
 - .4 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
 - .5 CSA W55.3, Certification of Companies for Resistance Welding of Steel and Aluminum.
 - .6 CSA W59, Welded Steel Construction, (Metal Arc Welding).
- .3 Current versions of Canadian Sheet Steel Building Institute (CSSBI):
 - .1 CSSBI 10M, Standard for Steel Roof Deck.
 - .2 CSSBI 12M, Standard for Composite Steel Deck.
- .4 American Society for Testing and Materials (ASTM International):
 - .1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .5 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
- .6 Factory Mutual Insurance Company:
 - .1 FM Global Property Loss Prevention Data Sheet 1-29, Roof Deck Securement and Above Deck Roof Components.

1.3 QUALITY ASSURANCE

- .1 In accordance with Section 01 43 00 – Quality Assurance.
- .2 Qualifications
 - .1 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel and/or CSA W55.3 for resistance welding.
 - .2 Welders to be CWB approved for deck welding by Canadian Welding Bureau.
 - .3 Engage a Professional Engineer licensed and insured in the Province of Ontario to be responsible for design and installation of all decking.
 - .4 The Professional Engineer designing steel decking to hold a Certificate of Authorization, and to carry min. \$1,000,000.00 in liability insurance

1.4 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 steel decking and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 When requested, provide data to substantiate deck load capacity, including diaphragm shear capacity.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
 - .2 Submit design calculations if requested by the Consultant.
 - .3 Submit 4 hard copies or unlocked PDF documents to the Consultant for review at least 4 weeks prior to fabrication and/or delivery.
 - .4 Indicate deck layout, profile, dimensions, base steel thickness, metallic coating designation, connections to supports and between sheets, projections, openings, reinforcement details and accessories, and extent of protected zones on supporting structural steel.
 - .5 Indicate details of temporary shoring of steel deck, such as location, time and duration of placement and removal of shoring for concrete filled decks.

1.5 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect decking from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2 Products

2.1 **DESIGN CRITERIA**

- .1 Design steel deck to CSA S136, CSSBI 10M and CSSBI 12M.
- .2 Design steel deck and connections to steel framing to carry dead, live and other loads including lateral loads, diaphragm action, composite deck action, and uplift as indicated.
- .3 Deflection under specified live load not to exceed 1/240 of span, except that when deflection-sensitive finishes are supported directly from deck, live load deflection not to exceed 1/360 of span. The incremental portion of long-term deflection for floor deck not to exceed 1/480 (under live load, superimposed dead load, shrinkage and creep).
- .4 Where vibration effects are to be controlled as indicated, dynamic characteristics of decking system to be designed to be in accordance with CSA S16.
- .5 Design deck and connections for indicated diaphragm action, including anchorage and side laps, in accordance with CSSBI "Design of Steel Deck Diaphragms" and Hilti Product Technical Guide (for Powder Actuated Fasteners). Increase deck thickness if required by diaphragm design.
- .6 Conform to Factory Mutual FM class 90 approval rating requirements.
- .7 Deck profiles and welding to satisfy requirements of any Fire Rated Assembly Design specified for the Project.
- .8 Use only 19mm puddle welds in areas where deck supports are within structural steel protected zones.
- .9 Make sections continuous over 3 spans or increase thickness of material to give the equivalent stiffness and strength of a 3-span deck.
- .10 If increased wind uplift loads applicable at roof edges and corners are not specifically noted on Structural Drawings, increase the minimum design wind uplift shown (which is applicable in the zones away from roof edges) in accordance with the Users's Guide to NBC – Structural Commentaries (Part 4 of Division B).

2.2 MATERIALS

- .1 Steel Deck: Zinc-iron Alloy (ZF) coated steel sheet: to ASTM A653/A653M structural quality Grade 275, with ZF75 coating, for interior surfaces not exposed to weather.
- .2 Galvanized deck: Zinc (Z) coated steel sheet: to ASTM A653/A653M structural quality Grade 275, with Z275, coating, regular spangle surface, chemically treated for unpainted finish for exterior surfaces exposed to weather or interior spaces with high humidity as noted on the structural drawings.
- .3 Decks to be painted: zinc-iron alloy coated decks suitable for finish painting.
- .4 Aluminum-zinc alloy (AZ) coated steel sheet: to ASTM A792/A 792M structural quality grade 275, with AZ 150 coating, surface, chemically treated for paint finish, for exterior surfaces exposed to weather or interior spaces with high humidity as noted on the structural drawings.
- .5 Fasteners for galvanized deck and prefinished deck: coated or stainless steel, hex head, self-tapping screws with EPDM bonded washers.
- .6 Fasteners for deck to wood supports: galvanized screws with flat seal washers.
- .7 Powder-actuated fasteners: Hilti Decking Fastening System.
- .8 Acoustic insulation: fibrous glass 17.5 kg/m³ (1.1 lb/ft³) density minimum profiled to suit deck flutes.
- .9 Closures: as indicated and in accordance with manufacturer's recommendations. Minimum base steel thickness of 0.76 mm. Metallic coating same as deck material
- .10 Cover plates, cell closures and flashings: steel sheet with minimum base steel thickness of 0.76 mm (22 gauge) minimum. Metallic coating same as deck material.
- .11 Primer: zinc rich, ready mix to CAN/CGSB-1.181.
 - .1 VOC limit 250 g/L maximum
 - .2 VOC limit 350 g/L maximum to SCAQMD Rule 1113.
- .12 Headed shear studs: to CSA W59, Appendix H, min. Fy=350MPa Type B.

2.3 TYPES OF DECKING

- .1 Steel roof deck:
 - .1 38 mm (1 1/2") maximum deep profile, 152 mm (6") flute spacing, non-cellular, interlocking side laps.
 - .2 76 mm (3") maximum deep profile, 152 mm (6") or 203 mm (8") flute spacing, non-cellular, interlocking side laps.
- .2 Composite steel deck:
 - .1 38 mm (1 1/2") maximum deep profile, 152 mm (6") flute spacing, non-cellular, inverted embossed fluted profile, interlocking side laps.

- .2 51 mm (2") maximum deep profile, 152 mm (6") flute spacing, non-cellular, inverted embossed fluted profile, interlocking side laps.
- .3 76 mm (3") maximum deep profile, 203 mm (8") flute spacing, non-cellular, inverted embossed fluted profile interlocking side laps.
- .4 76 mm (3") maximum deep profile, 305 mm (12") flute spacing, non-cellular, embossed fluted profile interlocking side laps.
- .3 In addition, for composite floor deck over composite steel beams with shear studs, minimum average width of concrete ribs to be:
 - .1 95 mm for 38 mm (1.5") deep steel deck (inverted deck).
 - .2 152 mm for 76 mm (3") and 51 mm (2") deep steel deck.

2.4 FABRICATION

- .1 Conform to CSA S136 and CSA W59.
- .2 Fabricate sections from steel sheets by rolling. Form integral ribs which will bear on supports and form interlocking male and female side laps.

3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Structural steel work: in accordance with CSA S136, CSSBI 10M and CSSBI 12M.
- .2 Welding: in accordance with CSA W59, except where specified otherwise.

3.3 ERECTION

- .1 Erect steel deck as indicated and in accordance with CSA S136, CSSBI 10M and CSSBI 12M and in accordance with reviewed erection drawings.
- .2 Lap ends: to 50 mm (2") minimum.
- .3 Weld and test stud shear connectors through steel deck to steel joists/beams below in accordance with CSA W59.
- .4 Do not overload structure during erection. Place deck bundles near columns.

- .5 Align deck end to end for accurate fit with corresponding sections. Sections to be parallel, even and straight.
- .6 Locate deck rib directly over perimeter steel beams spanning parallel to deck and at same elevation as underside of deck.
- .7 For exposed deck end laps, do not extend lower deck sheet past the face of the supports.
- .8 Exercise particular care in erection of exposed deck. Sections which are dented, damaged or perforated by welding will be rejected.
- .9 Connections
 - .1 Apply spray paint to deck immediately above the protected zones which are indicated on structural steel members by a contrasting shop paint. Do not attach studs nor powder actuated fasteners to these zones. Only acceptable deck fasteners within the protected zones are 19mm puddle welds. If any other fasteners are used, the affected structural steel members will have to be removed and replaced.
 - .2 Immediately after deck is permanently secured in place, touch up metallic coated top surface with compatible primer where burned by welding.
- .10 Prior to concrete placement, steel deck to be free of soil, debris, standing water, loose mil scale and other foreign matter.
- .11 Temporary shoring, if required, to be designed to support construction loads, wet concrete and other construction equipment. Do not remove temporary shoring until concrete attains 75% of its specified 28-day compression strength.
- .12 Place and support reinforcing steel as indicated.

3.4 CLOSURES

- .1 Install closures in accordance with approved details.
 - .1 Reinforce edge of free spanning deck with channel shaped closure fitted to edge and fastened to deck.
 - .2 Provide flashing at columns and points of discontinuity to prevent leakage of mortar when concrete is placed over deck.
 - .3 Provide edge forming for concrete slabs over deck. Fasten to deck.

3.5 OPENINGS AND AREAS OF CONCENTRATED LOADS

- .1 Structural Drawings do not show all openings required. Refer also to Architectural, Mechanical and Electrical drawings. Cut all opening required by other trades.
- .2 No reinforcement required for openings cut in deck which are smaller than 150 mm (6") square.
- .3 Frame deck openings with any one dimension between 150 to 300 mm (6" to 12") as shown on the structural drawings, except as otherwise indicated.

- .4 For deck openings with any one dimension greater than 300 mm (12") and for areas of concentrated load, reinforce in accordance with structural framing details, except as otherwise indicated.
- .5 Temporary shoring, if required, not to be removed until concrete attains 75% of its specified 28-day compression strength.

3.6 CONNECTIONS

- .1 Install connections in accordance with CSSBI recommendations as indicated.
- .2 Use connections specified on reviewed shop drawings, to suite uplift, diaphragm shear, requirements of any Fire Rated Assembly Design and FM requirements specified for the Project.
- .3 Connect deck to supporting beams using arc spot welds, mechanical fasters or power actuated fasteners. Connect male and female side laps using seam or arc puddle welds, mechanical fasteners or by interlocking with a button punch
- .4 Use coated or stainless-steel fasteners for all prefinished and galvanized deck, as well as for decks at steep slopes. Side laps for prefinished or galvanized deck to be mechanically interlocked.
- .5 Predrill holes for screws connecting deck to timber beams. Screws shall tap metal and extend into wood, clamping deck to wood.
- .6 Fasten stud shear connectors to composite beams by welding to beams, through deck where necessary, with a full 360 degrees weld capable of developing 120% of the shear values listed in CAN/CSA S16. Procedures shall conform to the recommendations of the stud manufacturer. Refer to Inspection and Testing for testing procedures. Replace studs that crack in the weld or shank

3.7 FIELD QUALITY CONTROL

- .1 Refer to Section 01 45 00 Quality Control.
- .2 Inspection and testing:
 - .1 An Inspection and Testing Agency (certified to CSA W178.1 & 2) will be appointed to carry inspection and testing of steel decks.
 - .2 The Inspection agency will submit reports to the Consultant, Structural Engineer, Contractor and Municipal Authorities covering the Work inspected and provide details of errors or deficiencies observed.
 - .3 Work will be inspected when erected.
 - .4 Inspection will include:
 - .1 Checking that mill test reports are properly correlated to materials.
 - .2 Confirming that all materials meet specifications.
 - .3 Checking welders' CWB certification.
 - .4 Checking deck types and gauge thicknesses.
 - .5 Checking all welding, fastening and button punching.

- .6 Checking of all reinforcement required at holes cut in deck.
- .7 Checking installation of sheet metal strips and edge reinforcing.
- .8 Checking and testing field welded stud shear connectors as follows:
 - .1 The Inspector will visually check all stud shear connectors on composite steel beams. At least on stud in every 150 and all studs which do not have a complete end weld, which are repaired by welding, or which show less than the normal reduction in height due to welding will be bent 15 degrees from their axis towards the nearest support, as specified in CSA-W59. Bent studs that show no sign of failure will be accepted and shall remain in the bent position. Studs that crack in weld, base metal or shank will be rejected. Studs with end welds covering less than 85% of the perimeter will be rejected even if they pass the bend test.

3.8 PROTECTION

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

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for load-bearing metal studs work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A123, Specification for Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products.
- .2 ASTM A653/A653 M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .3 ASTM C1002, Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- .4 ASTM C1280, Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing.
- .5 CISC/CPMA 1.73a, A Quick-Drying One-Coat Paint for Use on Structural Steel.
- .6 CSA W47.1, Certification of Companies for Fusion Welding of Steel.
- .7 CSA W55.3, Certification of companies for resistance welding of steel and aluminum.
- .8 CSA W59, Welded Steel Construction (Metal Arc Welding).
- .9 CSA S136, North American Specification for the Design of Cold Formed Steel Structural Members.
- .10 Canadian Sheet Steel Building Institute CSSBI 52M, Lightweight Steel Framing Binder.

1.3 **DESIGN REQUIREMENTS**

- .1 Design load-bearing metal studs to withstand live, dead, lateral, wind, seismic, handling, transportation, and erection loads.
- .2 Design load-bearing metal studs for exterior soffit framing
- .3 Design load-bearing metal studs based on Limit States Design principles using factored loads and resistances. Loads and load factors to be in accordance with the National Building Code (NBC). Resistance factors to be determined in accordance with the NBC and CAN/CSA-S136-M.
- .4 Design bridging to prevent member rotation and member translation perpendicular to the minor axis. Provide for secondary stress effects due to torsion between lines of bridging.

- .5 Design load-bearing metal studs in accordance with following Climatic Design Data for Toronto contained in the Ontario Building Code:
 - .1 Design temperature: January 1%, July 2 ½%.
 - .2 Wind (Hourly wind pressures): 1 in 50 year occurrence.
- .6 Design load-bearing metal studs for the full specified design wind load with the following deflection limits:
 - .1 Brick and stone veneer: L/720.
 - .2 Metal siding and panels: L/360.
- .7 Design load-bearing metal studs without relying on sheathing or gypsum board to resist torsion and weak axis buckling.
- .8 Design load-bearing metal studs framing for exterior soffit to support exterior soffit system specified in Section 07 40 23. Used hot-dipped galvanized engineered steel stud framing.

1.4 SUBMITTALS

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data including sheathing and accessory materials in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and system limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Wall construction, load-bearing metal stud wall system, design loads, member sizes, materials, component details, depth and gauge designation exclusive of coatings, location and spacings of framing members, connection and bracing details, bearing, anchorage, loadings, temporary bracing, welds, types and locations of mechanical fasteners, splices, permanent bracing, strapping and sheathing.
 - .2 Indicate locations, dimensions, openings and requirements of related work.
 - .3 Indicate welds by welding symbols as defined in CSA W59.
 - .4 Complete engineering design data to confirm that load-bearing metal studs meet design requirements specified.
 - .5 Design load-bearing metal studs framing for exterior soffit to support exterior soffit system specified in Section 07 40 23. Used hot-dipped galvanized engineered steel stud framing.
- .3 Certificates and Reports: Prior to commencement of work, submit 2 certified copies of load-bearing metal stud mill reports covering material properties.

1.5 **QUALITY ASSURANCE**

- .1 Retain a Professional Engineer, licensed in Province of Ontario, with experience in work of comparable complexity and scope, to perform following services as part of work of this Section:
 - .1 Design of load-bearing metal studs.
 - .2 Review, stamp, date and sign shop drawings and design calculations.
 - .3 Conduct shop and on-site inspections, prepare and submit written inspection reports verifying that this part of Work is in accordance with Contract Documents and reviewed shop drawings.
- .2 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel structures and/or CSA W55.3 for resistance welding of structural components.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

- .1 Bailey Metal Products.
- .2 Sanders Steel Inc.
- .3 Steelform (West)/Fusion (East) Divisions of Imperial Building Products Ltd.
- .4 Or approved alternative.

2.2 **MATERIALS**

- .1 General: All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.
- .2 Steel: to CSA S136, Grade A to D steel with Z275 zinc coating designation in accordance with ASTM A653/A653M.
- .3 Welding materials: to CSA W59 and certified by Canadian Welding Bureau.
- .4 Screws: pan head, self-drilling, self-tapping sheet metal screws, corrosion protected to minimum requirements of CSSBI, length to suit intended end use.
- .5 Anchors: concrete expansion anchors or other suitable drilled type fasteners.
- .6 Bolts, nuts, washers: hot dipped galvanized to ASTM A123, 600 g/m² zinc coating.
- .7 Primer paint: CAN/CGSB-1.40-M or CPMA 1.73a.
- .8 Insulation: In accordance with Section 07 21 00.
- .9 Sill Plate Gasket: Polyethylene foam, moisture resistant, 4.8 mm thick; 'FoamSealR' by Owens Corning or approved alternative.

- .10 Isolation coating: Black bituminous coating, acid and alkali resistant material.
- .11 Sheathing screws: to ASTM C1002, Type S, corrosion resistant, 12.7 mm penetration into steel, complete with 38 mm diameter washers.
- .12 Exterior grade gypsum sheathing: ASTM C1177/C1177M, 12.7 mm thick, 'GlasRoc Brand Sheathing' with EGRG by CertainTeed Gypsum Canada, 'Securock Glass-Mat Sheathing' by CGC Inc. or 'Dens-Glass Sheathing' by Georgia-Pacific Canada LP.
- .13 Exterior grade gypsum sheathing (Type X): ASTM C1177C1177M, 15.9 mm thick, unless otherwise indicated, 'GlasRoc Brand Sheathing Type X' with EGRG by CertainTeed Gypsum Canada, 'Securock Glass-Mat Sheathing Firecode X' by CGC Inc. or 'Dens-Glass Fireguard Sheathing' by Georgia-Pacific Canada LP.

2.3 **METAL FRAMING**

- .1 Metal studs: to CAN/CSA S136, fabricated from zinc coated steel, depth as indicated. Minimum steel thickness to be 0.91 mm.
- .2 Stud tracks: fabricated from same material and finish as metal studs, depth to suit.
 - .1 Bottom track: single piece.
 - .2 Top track: two piece telescoping or single piece as required by design.
- .3 Bridging: fabricated from same material and finish as studs, 38 x 12 x 1.22 mm minimum thickness.
- .4 Angle clips: fabricated from same material and finish as studs, 38 x 38 mm x depth of metal stud, 1.22 mm minimum thickness.
- .5 Tension straps and accessories: In accordance with reviewed shop drawings and as recommended by manufacturer.

3 Execution

3.1 **EXAMINATION**

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

3.2 **PREPARATION**

- .1 Verify substrate surfaces are solid, free from surface water, frozen matter, and other foreign matter detrimental to performance. Ensure environmental and site conditions are suitable for installation of system.

3.3 **INSTALLATION**

- .1 Install load-bearing metal studs in accordance with reviewed shop drawings and manufacturer's written instructions.
- .2 Install sill plate gasket under bottom track at foundation wall locations and in locations indicated in accordance with manufacturer's written instructions. Butt all end and perpendicular joints tightly.
- .3 Perform work in accordance with CSSBI 52M. Perform welding in accordance with CSA W59.
- .4 Erect studs plumb, aligned and securely attached with 2 screws minimum at each point of attachment, or welded in accordance with manufacturer's recommendations. Anchor tracks securely to structure at 800 mm o.c. maximum, unless lesser spacing prescribed on shop drawings.
- .5 For telescoping tracks install 50 mm minimum telescoping track at top of walls where required to accommodate vertical deflection. Nest top track into deflection channel a minimum of 30 mm and a maximum of 40 mm. Do not fasten tracks together. Stagger joints.
- .6 Seat studs into bottom tracks and top track. Install studs at not more than 50 mm from abutting walls, openings, and each side of corners and terminations with dissimilar materials.
- .7 Brace metal studs with horizontal internal bridging at spacing shown on reviewed shop drawings. Fasten bridging to steel clips fastened to metal studs with screws or by welding.
- .8 Frame openings in stud walls to adequately carry loads by use of additional framing members and bracing as detailed on shop drawings.
- .9 Cutouts: Limit distance from centerline of last unreinforced cutout to end of member to less than 300 mm.
- .10 Touch up welds with coat of zinc rich primer.
- .11 Erection Tolerances;
 - .1 Plumb: not to exceed 1/500th of member length.
 - .2 Camber: not to exceed 1/1000th of member length.
 - .3 Spacing: not more than 3 mm from design spacing.
 - .4 Gap between end of stud and track web: not more than 4 mm.
- .12 Install batt insulation in accordance with Section 07 21 00.
- .13 Apply isolation coating over entire contact surfaces of all dissimilar materials to prevent electrolytic action for protection from galvanic corrosion.

3.4 SHEATHING INSTALLATION

- .1 Install sheathing materials in accordance with ASTM C1280, reviewed shop drawings, and manufacturer's written instructions.
- .2 Install load-bearing metal studs framing for exterior soffit to support exterior soffit system specified in Section 07 40 25, in conjunction with soffit system shop drawings and in coordination with soffit system Contractor.
- .3 Install sheathing with long dimension perpendicular to metal studs, offset joints and butt tight, centre edges of sheathing over metal studs, mechanically fasten with specified fasteners and washers in accordance with manufacturer's instructions.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for the miscellaneous and metal fabrication work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 AAMA 611, Voluntary Standards for Anodized Architectural Aluminum.
- .2 AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels - Series: Components, Coatings and Finishes.
- .3 ANSI, H35.1M Alloy and Temper Designation Systems for Aluminum (Metric).
- .4 ASTM A123, Specification for Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products.
- .5 ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- .6 ASTM A269, Specification for Seamless and Welded Austenitic Stainless Steel Sanitary Tubing for General Service.
- .7 ASTM A276, Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
- .8 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- .9 ASTM A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
- .10 ASTM A563M, Specification for Carbon and Alloy Steel Nuts [Metric].
- .11 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .12 ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .13 ASTM B211, Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
- .14 CISC/CPMA 1.73a, A Quick-Drying One-Coat Paint for Use on Structural Steel.
- .15 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steels.
- .16 CAN/CSA S16.1-M, Limit States Design of Steel Structures.

- .17 CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.
- .18 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
- .19 CSA W48, Filler Metal and Allied Materials for Metal Arc Welding.
- .20 CSA W59-M, Welded Steel Construction (Metal Arc Welding).
- .21 CAN/CSA W117.2-M, Safety in Welding, Cutting and Allied Processes.
- .22 CAN/CGSB 1.40-M, Primer, Structural Steel, Oil Alkyd Type.
- .23 CGSB 85-GP-16M, Painting Galvanized Steel.
- .24 NAAMM, The National Association of Architectural Metal Manufacturers.
- .25 Steel Structures Painting Council (SSPC), Steel Structures Painting Manual, Vol. 2.

1.3 DESIGN REQUIREMENTS

- .1 Design details and connections, where not shown on Drawings, in accordance with CAN/CSA-S16.1 and CSA S136.1.
- .2 Design steel with the following minimum environmental requirements:
 - .1 Hollow Structural Sections (HSS):
 - .1 Recycled content: 30%.
 - .2 Maximum Global Warming Potential (before compensation): A1-A3.
 - .3 Carbon content: 2.6 kg CO₂e / kg, 20432.87 kg CO₂e / m³.
 - .2 Structural steel profiles:
 - .1 Recycled content: 97%.
 - .2 Maximum Global Warming Potential (before compensation): A1-A3.
 - .3 Carbon content: 0.74 kg CO₂e / kg, 5827.05 kg CO₂e / m³.
 - .3 Hot-rolled merchant bar:
 - .1 Maximum Global Warming Potential (before compensation): A1-A3.
 - .2 Carbon content: 0.72 kg CO₂e / kg, 5675.55 kg CO₂e / m³.

1.4 SUBMITTALS

- .1 Shop drawings:
 - .1 Submit shop drawings for fabrication and erection of miscellaneous and metal items in accordance with Section 01 33 00 indicating:
 - .1 Materials, core thicknesses, class of finish (AMP 555), connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.
 - .2 Ensure shop drawings are of one uniform size and based on field measurements.

1.5 QUALITY ASSURANCE

- .1 Retain a Professional Engineer, licensed in the Province of Ontario, with experience in work of comparable complexity and scope, to perform the following services as part of the work of this Section:
 - .1 Design metal stairs, support framing, and metal fabrication items that are required to resist live, dead, lateral, wind, or seismic loads.
 - .2 Review, stamp, date and sign shop drawings.
- .2 Workmanship: Fabricate work of this Section to meet the required class of workmanship indicated below in accordance with NAAMM's AMP 555, Section 8.
 - .1 Class 1: for use on direct exposed to view fabricated items:
 - .1 Exposed surfaces are finished smooth with pits, mill marks, nicks, burrs, sharp edges, and scratches filled or ground off. Defects should not show when painted, polished, or finished.
 - .2 Welds should be concealed where possible. Exposed welds are ground to small radius with uniform sized cove unless otherwise noted.
 - .3 Distortions should not be visible to the eye.
 - .4 Exposed joints are fitted to a hairline finish.
- .3 Mock-up:
 - .1 Construct one mock-up of each miscellaneous and metal fabrication items in a location accepted by Consultant.
 - .2 Provide mockup samples indicating materials and weld quality of: all guards and exterior fence types, typical handrail bracket and handrail assembly, alum and metal plate countersunk fastening details with fasteners.
 - .3 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
 - .4 Mock-up may form part of Work if accepted by Consultant. Mock-ups which do not form part of Work are to be removed from Site during final cleanup, or when directed by Consultant.
- .4 Execute welding by firms certified in accordance with CSA W47.1 Division 1 or 2.1. Ensure welding operators are licensed per CSA W47.1 for types of welding required by Work.
- .5 Perform stainless steel work in accordance with NAAMM, Code of Standard Practice for the Metal Industry, Workmanship, Class 1.

2 Products2.1 **MATERIALS**

.1 General:

- .1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits and emissions requirements.
 - .2 Wherever possible, metals used in work of this Section are to contain recycled content.
 - .3 Unless detailed or specified herein, 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, sizes and shapes as shown.
- .4 Aluminum sheet: ASTM B209 and ANSI H35.1 AA1100 aluminum alloy, H14 temper, thickness as indicated on drawings.
- .5 Aluminum plates, extrusions and channels: ASTM B211 and ANSI H35.1 AA6063 alloy, T6 temper. Profiles, dimensions, finishes and colours as indicated on drawings and schedules for both interior and exterior items.
- .6 Stainless steel:
- .1 Sheet and plate: ASTM A480/A480M, Type 316.
 - .2 Shapes: ASTM A276, Type 316.
 - .3 Tubing: ASTM A269, Type 304, to AISI No. 4 finish. Size as shown.
 - .4 Finish: AISI No. 4. or X-L Blend S.
 - .5 Size(s): Size as shown
- .7 Welding materials: CSA W48 and CSA W59-M.
- .8 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 recessed flathead countersunk socket hexagonal drive fasteners including 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.

- .9 Finish coating: Epoxy Polyester coating conforming to AAMA 2603 with finish and colour as indicated on Interior Finishes Schedule; 'Interpon D1000' by Interpon Powder Coatings (Akzo Nobel) or approved alternative. Provide manufacturers recommended primer.
- .10 Primer paint: CAN/CGSB-1.40-M or CPMA 1.73a. Shop applied steel primer for use on steel in pool environment areas and as required. 'Steel Spec 1003' by Sherwin Williams or approved alternative.
- .11 Galvanized primer paint: Inorganic zinc rich primer. For use on galvanized fabrications where touch up is to remain unpainted in finished work; Carbozinc 11WB by Carboline Company, Catha-Coat 305 by Devoe Coatings or Zinc Clad XI by Sherwin Williams.
- .12 Drilled inserts: "HSL-3" by Hilti Inc. or "Dynabolt Sleeve Anchors" by ITW Construction Products, heavy-duty anchors, sizes as shown.
- .13 Adhesive anchor system: 'HIT HY 200 Injectable Mortar with Hilti HAS Stainless Steel Anchor Rod System' by Hilti Ltd. or approved alternative by ITW Construction Products, complete with all components required for a complete installation.

2.2 **FABRICATION**

- .1 Fit and assemble work in shop where possible. Execute work in accordance with details and reviewed shop drawings.
- .2 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.
- .3 Ensure exposed welds are continuous, where possible, 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. Provide minimal fillet welds and grind off overburden to provide square inside corners.
- .4 Execute shop welding to requirements specified .
- .5 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.
- .6 Assemble members without twists or open joints.
- .7 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.
- .8 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.

- .9 Provide countersunk fasteners with hexagonal head screw for prefinished aluminum and other items.

2.3 FABRICATED ITEMS

- .1 Refer to Drawings for details of metal fabrication work and related items not specifically listed in this Section.
- .2 Where work is required to be built into work of other Sections supply such members to respective Sections.
- .3 Provide miscellaneous and metal fabrications indicated on the drawings, listed below, and not indicated to be supplied under other Sections. Provide miscellaneous and metal fabrications including but not limited to the following:
- .4 Metal pan stairs:
 - .1 Fabricate steel channel stringer of size, construction and attachment to structure as shown. Close exposed sides and ends of stringers with steel closure plates welded to edges of exposed flange edges, sizes indicated as per Drawings.
 - .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. Fabricate landings for concrete fill of same material as stair treads, unless ribbed metal deck or composite wood form is shown.
 - .3 Cast in place concrete landings in accordance with Division 3.
 - .4 Support treads, risers and landings as detailed on reviewed shop drawings.
- .5 Handrails, guardrails, and posts:
 - .1 Design railings and guards to withstand minimum horizontal and vertical loads as required to meet requirements of authorities having jurisdiction. In no instance shall load design of railings be less than 3.0 kN/m horizontally and 1.5 kN/m vertically.
 - .2 Fabricate railings, handrails, and guardrails as shown on drawings.
 - .3 Handrail bracket: Fabricate as shown. After fabrication, galvanize bracket in accordance with ASTM A123.
 - .4 Weld handrails bracket to stainless steel handrails as indicated on Architectural Drawings and details.
- .6 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. Do not use twisted rods for grating.
- .7 Stainless steel pipe handrails: to ASTM A269, Type 316, to AISI No. 4 finish brushed. Sizes as indicated.

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- .8 Masonry lateral support angles:
 - .1 Supply only, to Section 04 20 00 for installation, all horizontal lateral support anchors at top of non-load-bearing masonry walls.
 - .2 Refer to Structural Drawings for size and spacing of required support anchors. Provide drilled holes as required for anchorage.
 - .3 Galvanized for all exterior wall and unheated and high humidity locations.
 - .4 Provide all pool environment steel with epoxy finish.
 - .5 Finish visually exposed exterior angles in accordance with Section 09 91 00.
 - .9 Support framing: 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. Provide framing for the following:
 - .1 Accordion folding doors.
 - .2 Sectional Overhead Doors
 - .3 Folding partition supports.
 - .4 Partition bracing diagonal or structural steel stud at long full height interior screens.
 - .5 Steel angle for horizontal girt, vertical hanger, and diagonal braces to support interior screens.
 - .6 Other items that require support not listed here , refer to architectural drawings and details for the additional items.
 - .10 Hoist beams and divider beams: Structural steel sections, sizes indicated on drawings, Finish: Prime painted.
 - .11 Gratings:
 - .1 Fabricate gratings to sizes shown.
 - .2 Pressure lock bars to form rigid panels of required size. Band open ends of bars. Do not use twisted shape bars.
 - .3 Make jointing in built-up sections with hairline joints in least conspicuous location. Assemble work securely and reinforce where necessary with similar fastenings. Countersink screws unless otherwise noted. Grind exposed surfaces of rolled steel shapes or fill perfectly smooth.
 - .4 Supply items that are required to be built into concrete and masonry.
 - .5 Fabricate, finish and assemble items in shop where possible, consistent with size and shipping. Minimize field assembly.
 - .6 Mitre cut metal mouldings for angles. Butt joints will not be accepted for these locations.
 - .7 Provide grating access panels as indicated on drawings with heavy duty hinges, latched handle, and locking hasp.
 - .12 Steel ladders:
 - .1 Fabricate complete with steel stiffeners, rungs, angle rails, bent plate straps or angle brackets as shown.
 - .2 Ladders in elevator pits shall extend 1220 mm high above finished floor.
 - .3 Provide safety cages around ladders where indicated on Drawings, in accordance with Ministry of Labour requirements.
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- .13 Vanity counter supports:
 - .1 Provide supports for vanity counters. Construct supports of sizes as noted on Drawings, galvanized steel plate as detailed in pool environment and as noted on Architectural Drawings.
 - .2 Provide all drill holes required for concealed anchorage of counters and for anchoring to building structure.
- .14 Bench supports:
 - .1 Supply only, for installation under work of Section 06 20 00, bench supports constructed of galvanized steel HSS sizes noted.
 - .2 Construct supports as detailed. Provide all drill holes required for concealed anchorage of wood bench and for anchoring to building structure.
- .15 Miscellaneous steel brackets, dance bar supports, bar supports, 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 and galvanized steel for all items located in Pool or change room areas.

2.4 STAINLESS STEEL WORK

- .1 Take all necessary precautions to safeguard against latent surface discolouration due to disturbance of the natural protective oxide coating of the material or to contamination from other sources. All stainless steel to be Type 316 as indicated on Architectural and Aquatics Drawings.
- .2 Workmanship shall be the best standard practice for this type of work. Execute stainless steel work in accordance with the applicable instructions set forth in Atlas Stainless Steels' "Technical Data" handbook on stainless steel.
- .3 Do all stainless steel fabrication in clean shops, located away from areas where carbon steel is burnt, ground, or cut with abrasive wheels to ensure that carbon steel dust will not be embedded into the stainless steel, and as follows:
 - .1 In fabrication of stainless steel do not use tools and dies which have been used on carbon steels.
 - .2 Ensure tools and dies use for forming and cutting stainless steel are free of nicks and other damage.
 - .3 Do not use carbon grits and grinding wheels which will imbed foreign particles into stainless steel surfaces. Use only stainless steel wool when wool polishing is required.
 - .4 Stainless steel items, on which rust stains appear, shall be replaced with new fabricated material.

2.5 ANCHORS AND FASTENING

- .1 Use weld studs of size not larger than 10 mm for attaching miscellaneous materials and equipment to building steel. If weight of item requires larger fasteners use clips or brackets and secure by welding or through bolting.
- .2 Use self drilling expansion type concrete anchors for attaching to masonry and concrete
- .3 Do not secure items to steel deck.
- .4 Use steel beam clamps of two bolt design to transmit load to beam web. Do not use C and I clamps.

2.6 WELDING

- .1 Perform welding by electric arc process.
- .2 Execute welding to avoid damage or distortion to Work. Execute welding in accordance with following standards:
 - .1 CSA W48 - for Electrodes. If rods are used, only coated rods are allowed.
 - .2 CSA W59-M and CSA W59S1-M for design of connections and workmanship.
 - .3 CAN/CSA W117.2-M - for safety.
- .3 Thoroughly clean welded joints and expose steel for a sufficient distance to perform welding operations. Finish welds smooth. Supply continuous and ground welds which will be exposed to view and finish paint.
 - .1 At railings and balustrades, continuously weld top and bottom and stitch weld along length.
- .4 Test welds for conformance and remove work not meeting specified standards and replace to Consultant's acceptance.

2.7 SHOP PAINTING

- .1 Clean steel to SSPC SP6 and remove loose mill scale, weld flux and splatter.
- .2 Shop prime steel with one coat of primer paint to dry film thickness of 0.07 mm. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 deg C. Paint items under cover and leave under cover until primer is dry. Follow paint manufacturer's recommendations regarding application methods, equipment, temperature, and humidity conditions.
- .3 Shop prime galvanized steel in accordance with CGSB 85-GP-16M.
- .4 Clean but do not paint surfaces being welded in field.
- .5 Do not paint surfaces embedded in concrete, but clean as if they were to be primed.

- .6 Do not prime steel to be fireproofed or to receive intumescent paint coating.
- .7 Do not prime machine finished surfaces, but apply an effective anti-rust compound.
- .8 Take precautions to avoid damage to adjacent surfaces.

2.8 **POWDER COAT FINISH**

- .1 Shop apply electrostatic coating in strict accordance with manufacturer's printed instructions.
- .2 Provide primer where required and one finish coat.
- .3 Ensure application of each coat into all corners, pinholes and other difficult areas and ensure full coverage to all surfaces.
- .4 Ensure a smooth finish, free of laps, sags, runs, pin holes, crawls and skips. Back lap all edges to achieve full coverage.

2.9 **HOT DIP GALVANIZING**

- .1 After fabrication, hot dip galvanize miscellaneous steel items as indicated and where located partially or wholly exterior to the building thermal insulation. After galvanizing, plug relief vents air tight with appropriate aluminum plugs as suitable and required for intended metal fabricated item. Straighten shapes and assemblies true to line and plane after galvanizing. Repair damaged galvanized surfaces with zinc rich primer in accordance with manufacturer's printed directions.
- .2 Hot-dip galvanize members in accordance with requirements of the following ASTM, with minimum coating weights or thicknesses as follows:
 - .1 Rolled, pressed and forged steel shapes, plates, bars and strips: ASTM A123; average weight of zinc coating per square/metre of actual surface, for 4.8 mm and less thickness members 600 g/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.

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 **TOUCH UPS**

- .1 Paint bolt heads, washers, nuts, field welds and previously unpainted items. Touch up shop primer damaged during transit and installation, with primer to match shop primer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, tool, equipment and services necessary for glazed decorative metal railing work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 AAMA CW-10, Care and Handling of Architectural Aluminum from Shop to Site.
- .2 ANSI H35.1/H35.1M, American National Standard Alloy and Temper Designation Systems for Aluminum.
- .3 ASTM B209M, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .4 ASTM B221M, Specification for Aluminum-Alloy Extruded Bars, Rods, Wires, Profiles and Tubes.
- .5 ASTM C920, Specification for Elastomeric Joint Sealants.
- .6 ASTM F738M, Specification for Stainless Steel Metric Bolts, Screws, and Studs.
- .7 CAN/CGSB 12.20-M, Structural Design of Glass for Buildings.
- .8 CSA-A500, Building Guards.
- .9 CSA S157/S157.1, Strength Design in Aluminum.

1.3 **DESIGN REQUIREMENTS**

- .1 Design glass balustrade systems to CSA-A500, CAN/CGSB-12.20-M and CSA-S157/S157.1. Perform stress analysis. Design units to accommodate live, dead, lateral, wind, seismic, handling, transportation, and erection loads.
- .2 Design glazed balustrade system incorporating a protection rail along the top edge of the glass consisting of stainless steel trim secured in place with structural silicone sealant as indicated on Drawings.

1.4 **SUBMITTALS**

- .1 Shop Drawings:
 - .1 Submit Shop Drawings in accordance with Section 01 33 00 indicating:
 - .1 Plans, sections, details, type of extrusions, profiles, thicknesses, finishes, closures, fillers, and end caps, and sealants.
 - .2 Products and glazing types.
 - .3 Anchorage inserts, system installation tolerances.
 - .4 Detailing, locations, and allowances for movement, expansion, contraction.

- .2 Samples:
 - .1 Submit two samples of following in accordance with Section 01 33 00.
 - .1 250 mm long samples of each type of extrusion and finish.
 - .2 250 x 200 mm samples of glass.
- .3 Close-out submittals: Submit data for incorporated into the Operations and Maintenance Manual as part of Section 01 78 00.

1.5 QUALITY ASSURANCE

- .1 Retain a licensed Professional Engineer, registered in Province of Ontario, to perform following services for decorative metal railings work:
 - .1 Design of glazed decorative metal railings.
 - .2 Review, stamp, and sign Shop Drawings.
 - .3 Conduct on-Site inspections and prepare and submit inspection reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Handle glazed partition work in accordance with AAMA CW-10.
- .2 Protect surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Do not remove before final cleaning of building.

2 Products

2.1 ACCEPTABLE MANUFACTURER(S) AND SYSTEM(S)

- .1 GRS Glass Railing Dry Glaze Taper-Locx System (GG):
 - .1 Aluminum shoe: rectangular base shoe, 120 mm high x 72 mm wide with satin anodized cladding, 'Posiglaze' by Stella Custom Glass Hardware, Inc or approved alternate.
 - .2 Square cap: Extruded aluminum with satin anodized finish, crisp corner cap rail,, 3.2 mm thick x 19 mm high x 25 mm outside width with square edges, U-channel rail cap. 'Cap Series' by Stella Custom Glass Hardware, Inc or approved alternative.
 - .3 Provide end closure caps in matching finish.

2.2 MATERIALS

- .1 General: All materials under work of this Section, including but not limited to, sealants and coatings are to have low VOC content limits.
- .2 Aluminum extrusions and channels: ASTM B221 and ANSI H35.1/H35.1M, 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/H35.1M, 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 A480/A480M, Type 316. Size as shown.
- .5 Glazing: The choice of glazing for this project shall conform to specified Design Requirements, reviewed Shop Drawings, and Authorities having Jurisdiction:
 - .1 Laminated Glass Balustrade
 - .1 (LG.1): Laminated glass for exterior glass guards (GG), 16.8 mm thick as per Section 08 80 00.
 - .2 (LG.2): Laminated interior glass guards, 16.8 mm thick as per Section 08 80 00.
- .6 Glazing gasket: Black EPDM roll-in glazing gasket; 'LBSG100' by CRL Canada or approved alternative.
- .7 Sealant: ASTM C920; Single-Component, silicone sealant; 'Spectrem 1' by Tremco or '790 Silicone Building Sealant' by Dow Corning Corporation. Colour as selected by Consultant.
- .8 Anchors, clips, and angles: Stainless steel.
- .9 Screws, bolts and other fasteners: ASTM F738M; Stainless Steel Type 316.
- .10 Provide series safety seals by CRL Canada or approve alternative, SMBSG Series at drop side of glass and MBSG series at inside side of glass.

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, fit, and secure framing joints and corners accurately, with flush surfaces, and hairline joints.
- .3 Conceal anchors, reinforcement and attachments from view. Fabricate reinforcement in accordance with design requirements.
- .4 Do not expose manufacturer's identification labels on assemblies.

3 Execution

3.1 **EXAMINATION**

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

3.2 INSTALLATION

- .1 Install glazed decorative metal railings work in accordance with reviewed Shop Drawings, manufacturer's written instructions.
- .2 Install work of this Section securely, in correct location, level, square, plumb, at proper elevations, free of warp or twist.
- .3 Install closures, and trim pieces.
- .4 Refer to Contract Drawings for glazing type locations. Install glazing in accordance with Section 08 80 00.
- .5 Install glass in balustrades properly centred with uniform bite and face and edge clearance, free from twist, warp or other distortion likely to develop stress.
- .6 Remove damaged or unacceptable Products and assemblies from Site and replace to Engineer's acceptance.

3.3 CLEANING

- .1 Clean surfaces of grime and dirt using acceptable and recommended means and methods.
- .2 Clean dust and drilling debris from under the base railing shoes prior to their installation.
- .3 Paint bolt heads, washers, nuts, field welds and previously unpainted items. Touch up shop primer damaged during transit and installation, with primer to match shop primer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for rough carpentry work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- .2 ASTM A325, Specification for Bolts Quenched/Tempered Steel Nominal Thread Diameter M16 - M36 For Structural Steel Joints.
- .3 ASTM A653, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .4 ASTM D2898, Standard Practice for Accelerated Weathering of Fire Retardant Treated Wood for Fire Testing.
- .5 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .6 ASTM F1667, Driven Fasteners: Nails, Spikes and Staples.
- .7 CAN/CSA O80 Series M, Wood Preservation.
- .8 CSA O121-M, Douglas Fir Plywood.
- .9 CAN/CSA O141, Softwood Lumber.
- .10 CSA O151-M, Canadian Softwood Plywood.
- .11 CSA O325, Construction Sheathing.
- .12 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .13 CWC, Canadian Wood Council, Wood Reference Book.
- .14 NLGA, Standard Grading Rules for Canadian Lumber, National Lumber Grades Authority

1.3 **QUALITY ASSURANCE**

- .1 Lumber identification: Grade stamp of an agency certified by the Canadian Lumber Standards Accreditation Board.
- .2 Plywood identification: Grade mark in accordance with applicable CSA standards.

- .3 Lumber quality: Carefully select individual pieces so that knots and obvious defects will not interfere with placing bolts, proper nailing or making proper connections.
- .4 Moisture Content of wood at time of construction shall be 19% maximum.
- .5 Each piece of pressure treated lumber and fire retardant treated lumber shall be shop marked with the pressure treatment brand and ULC monogram respectively, in accordance with CAN/CSA O80-M.
- 6. Dimensions of lumber shall conform to dressed sizes specified in CAN/CSA-0141 unless actual dimensions are otherwise indicated or specified.
- 7. Dimensional references to lumber on Drawings and in Specifications are to nominal sizes unless actual dimensions are indicated. Such actual dimensions shall be dry size.
- .8 Lumber defects: Discard wood with defects which will render a piece unable to serve its intended function. Lumber will be rejected by Consultant for excessive warp, twist, bow, crook, mildew, fungus, or mould, as well as for improper cutting and fitting, whether or not it has been installed.

1.4 **ENVIRONMENTAL REQUIREMENTS**

- 1. When it is required that wood maintain dimensional stability and tolerances to ensure accurate installation of later work, store and install it only in dry areas, and where no further installation of moist materials is contemplated.

1.5 **PRODUCT DELIVERY, STORAGE AND HANDLING**

- .1 Store materials in a dry area. Cover materials with tarpaulins or polyethylene sheets to prevent moisture absorption and impairment of structural and aesthetic properties. Vent to allow air movement. Tie covering to keep in place.

2 Products

2.1 **MATERIALS**

- .1 General: All materials under work of this Section, including but not limited to, adhesives are to have low VOC content limits.
- .2 Lumber: Softwood, G4S, moisture content 19% or less at time of installation, in accordance with the following:
 - .1 Lumber shall be of same species and grade, equally seasoned and shall be processed and stamped at same mill.
 - .2 CSA O141 and NLGA Standard Grading Rules for Canadian Lumber.
 - .3 Board quality: Construction or better.
 - .4 Dimension quality:

- .1 Structural joists, planks, and framing: No. 1 Select Structural.
- .2 Light framing: Construction.
- .3 Plywood: CSA O121-M, G1S unsanded, T & G, standard construction, laminated with waterproof adhesive, exterior grade, Thickness as indicated on drawings.
- 4. Sheathing: Douglas Fir, CSA 0121-M or CSA O151-M; Select-Tight Face, exterior grade, T & G.
- 5. Oriented Strand Board, CSA O325, engineered, mat-formed panel product made of strands, flakes or wafers sliced from small diameter, round wood logs and bonded with an exterior-type binder under heat and pressure. Thickness as indicated on drawings.
- .6 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.
- .7 Roof Lumber (TPO roof assemblies only): NLGA, 'C' Cedar Industrial Clear or better, Western Red Cedar, surfaced, kiln dried.
- .8 Surface applied wood preservative: Green coloured copper naphthenate or 5% pentachlorophenol solution, water repellent preservative or same copper based preservative as used for shop impregnation, in accordance with CAN/CSA O80.
- .9 Fire retardant treatment of lumber and plywood (interior and protected locations): 'Dricon FRT' fire retardant treatment by Biewer Lumber or approved alternative, conforming to ASTM E84, to provide a flame spread rating of 25 or less.
- .10 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.
- .11 Fasteners for use in pressure treated wood: Provide hot dipped galvanized fasteners complying to ASTM A153 and connectors in accordance with ASTM A653, Class G185 for non-structural members. Provide type 304 or 316 stainless steel fasteners and connectors for use in Structural, pressure treated wood.

3 Execution

3.1 **EXAMINATION**

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

3.2 **GENERAL**

- .1 Lay out work carefully and to accommodate work of others. Cut and fit accurately: erect in position indicated by Drawings.
- .2 Install rough carpentry to allow for expansion and contraction of the materials.
- .3 Cut work into lengths as long as practicable and with square ends. Align, level, square, plumb, and secure work permanently in place. Brace work temporarily as required. Join work only over solid backing.
- .4 Bore holes true to line and to same size as bolts. Drive bolts into place for snug fit, and use plates or washers for bolthead and nut bearings. Turn up bolts and lag screws tightly when installed, and again just before concealed by other work or at completion of Work.
- .5 Provide anchors, bolts, and inserts required for attachment of the work of this Section, to those performing the work of other Sections and who are responsible for their installation.
- .6 Do not attach work by wood plugs or blocking in concrete or masonry. Use lead shields, expansion shields, or similar methods only as approved by Consultant.

3.3 **MISCELLANEOUS WOODWORK**

- .1 Fit and install wood furring, strapping, grounds and blocking. Adequately size, correctly place and conceal members for finishes, fitments and for work under other Sections. Do not assume that Drawings show required work exactly or completely. Anchor wood members securely in place.
- .2 Install rough bucks, nailing strips and linings to rough openings as required for backing for frames and other work.
- .3 Except where steel supports are specifically shown, provide wood blocking and supports in metal stud partitions for fastening of item such as casework and other wall mounted accessories. Have respective trades approve the location of such wood blocking.
- .4 Bolt wood blocking or nailing strips to steel framing.
- .5 Align and plumb faces of furring and blocking to tolerance of 1:600.

- .6 Use fire retardant lumber for blocking/framing in ceiling\ spaces, partitions and bulkheads.

3.4 **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.

3.5 **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.

3.6 **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.

3.7 **SURFACE-APPLIED WOOD PRESERVATIVE**

- .1 Treat raw surfaces, drilled holes and cut ends of pressure treated wood with 2 coats of wood preservative immediately after cutting.
- .2 Apply preservative by dipping, by brush or by pouring into plugged holes to completely saturate surface.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products equipment and services necessary for the finish carpentry work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ANSI A208.1, Particleboard.
- .2 ANSI/HPVA HP-1, Hardwood and Decorative Plywood.
- .3 ANSI A208.2, Medium Density Fibreboard for Interior Use.
- .4 ANSI/NEMA LD 3, High-Pressure Decorative Laminates.
- .5 APA - The Engineered Wood Association.
- .6 ASTM F1667, Driven Fasteners: Nails, Spikes and Staples.
- .7 Architectural Woodwork Manufacturers Association of Canada (AWMAC).
- .8 Architectural Woodwork Standards (AWS) - Quality Standards for Architectural Woodwork.
- .9 CAN/CSA O141, Softwood Lumber.
- .10 CSA O151-M, Canadian Softwood Plywood.
- .11 National Hardwood Lumber Association (NHLA) Rules for the Measurement and Inspection of Hardwood and Cypress.
- .12 National Lumber Grades Authority (NLGA) Standard Grading Rules for Canadian Lumber.

1.3 **SUBMITTALS**

- .1 Shop drawings: Submit shop drawings of finish carpentry work in accordance with Section 01 33 00 indicating:
 - .1 Materials, thicknesses, sizes, finishes, wood species, grades, profiles, connection attachments, shop jointing, field jointing, reinforcing, anchorage, fastener types and sizes, location of exposed fastenings, mechanical and electrical service routes, service outlets, cutout locations, and sizes.
 - .2 Include erection drawings, plans, elevations, sections, and details as applicable.

- .2 Samples: Submit samples of the following in accordance with the requirements of Section 01 33 00:
 - .1 Two representative pieces of each type of wood to receive a stained or natural finish.
 - .2 Two representative pieces of each type of wood finished as specified.
 - .3 Two of each colour, pattern, gloss, and texture of compact and plastic laminate, in manufacturer's standard tag size.
 - .4 Two samples of laminated plastic joints, edging, cutouts and postformed profiles.
 - .5 Two of each solid surface, in 100 x 75 x 19 mm samples and with edge profiles.
 - .6 Two samples of melamine surfaced board, edging and postformed profiles.
 - .7 One of each item of finish carpentry hardware.
- .3 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 **QUALITY ASSURANCE**

- .1 Execute work of this Section by member of AWMAC, with 5 years experience in finish carpentry work of comparable complexity and scope. Submit proof of experience upon Consultant's request.
- .2 Fabricate finish carpentry work in accordance with AWS Quality Standards, Premium Quality materials and installation unless otherwise indicated. Perform work in accordance with the definition of Good Workmanship as defined in the AWS Quality Standards.
- .3 Remove and replace finish carpentry work which does not conform to the AWS Quality standards or as amended by these Specifications.
- .4 Mock-up:
 - .1 Shop fabricate one mock-up of a base cabinet, wall cabinet, and counter top and other items as requested for each type of surfacing specified, complete with hardware and shop applied finishes, installed in location acceptable to Consultant.
 - .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
 - .3 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver, store, and handle finish carpentry in accordance with the AWS Quality Standards. Control the temperature and humidity in accordance with the AWS recommendations, before, during, and after finish carpentry delivery, and also during storage and installation.

- .2 Cover finished work with heavy kraft paper or put in cartons during shipment. Protect installed surfaces by approved means. Do not remove until immediately before final inspection.

1.6 **EXTENDED WARRANTY**

- .1 Submit an extended warranty for compact and plastic laminate work of this Section in accordance with General Conditions, except that warranty period is extended to 2 years from date of Substantial Performance of the Work.
 - .1 Warrant against defects in material and workmanship including but not limited to opening of joints, cracking, shrinkage, warpage, and delamination of compact laminate.
 - .2 Coverage: Complete replacement including affected adjacent Work.

2 **Products**

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, adhesives, mastics, primers and sealants are to have low VOC content limits and emissions requirements by meeting either CDPH v1.2 2017 or Greenguard Gold.
- .2 Concealed framing lumber and plywood:
 - .1 Eastern Spruce, Balsam Fir, or Jack Pine, to CAN/CSA O141, NLGA, and AWS Custom Grade, S4S, average moisture content 7% +/- 2% at installation.
 - .2 Softwood plywood: CSA O151-M; 19 mm unless indicated otherwise, (G2S).
 - .3 Marine grade plywood: CSA O151-M, G1S, T & G, composed entirely of Douglas Fir or Western Larch, laminated with structural waterproof adhesive, exterior grade. Thickness and locations as indicated on the Drawings.
- .3 Hardwood lumber: Maple, conforming to NHLA and NAAWS Premium Grade, S4S, average moisture content 7% +/- 2% at installation.
- .4 Wood veneer:
 - .1 White Oak, conforming to ANSI/HPVA HP-1 having finishes and meeting grades as follows:
 - .1 Opaque finish, Grade B.
 - .2 (Window Sills): Transparent finish, Grade AA.
 - .2 Face veneer cut: Rift Cut.
 - .3 Sizes, thickness, and shapes as indicated.
 - .4 Solid wood for seating, as per Drawings and details.
- .5 Marine grade plywood (sinks, splashes, where shown): APA, Grade A-A, T & G, composed entirely of Douglas Fir or Western Larch, laminated with structural waterproof adhesive, exterior grade. Thickness as indicated on drawings.

- .6 Plastic laminate: Provide plastic laminates conforming to ANSI/NEMA LD 3 as follows:
 - .1 Flatwork face sheet: 1.2 mm thick, heavy wear resistance.
 - .2 Vertical interior face sheets: 0.8 mm thick.
 - .3 Postformed face sheet: 0.8 mm thick.
 - .4 Backing sheet: thickness to match face sheet, high pressure laminate, manufactured by same manufacturer as face sheet.
 - .5 Plastic laminate: As manufactured by Arborite, Formica, Forbo, Nevamar, Pionite and Wilsonart.
 - .6 Colours: To the later selection of the Consultant from manufacturer's standard colour range.
- 7. Melamine Surfaced Particleboard: ANSI A208.1, Grade M2 particleboard with a melamine impregnated decorative paper thermofused onto the surface. Edging to be done in minimum 3 mm thick PVC to match melamine colour. 'Panval Thermofused Melamine Panels' by Uniboard Canada Inc. or approved alternative Colours as follows:
 - .1 Interior millwork surfaces: To be later selected by the Consultant.
 - .2 Exterior millwork surfaces: Colour and pattern as selected by Consultant.
- .8 Medium Density Fibreboard (MDF), core or panel: ANSI A208.2; SCS and EPP certified, no-added formaldehyde, moisture resistant MDF panels engineered for interior high moisture areas, 'Medex' by SierraPine, 'Arauco MDF' by Flakeboard Company Limited or approved alternative; meeting the following minimum criteria:
 - .1 Density: 769 kg/m³.
 - .2 Internal bond: 1.38 N/mm².
 - .3 Modulus of rupture: 41.34 N/mm².
 - .4 Modulus of elasticity: 4134 N/mm².
 - .5 Moisture content: 4-6%.
- .9 Particle board core: ANSI A208.1, no-added formaldehyde, FSC certified particleboard containing recycled content, 'Purekor Platinum Particleboard' by Panel Source or approved alternative by SierraPine; meeting the following minimum criteria:
 - .1 Density: 720 kg/m³.
 - .2 Internal bond: 0.76 N/mm².
 - .3 Modulus of rupture: 25.4 N/mm².
 - .4 Modulus of elasticity: 2861 N/mm².
- .10 Solid surfacing:
 - .1 Minimum 12 mm thick sheet stock, provide with edge as per architectural drawings details and all cutouts as required.
 - .2 Installation and seam adhesives to be as recommended by solid surfacing manufacturer, colour matched to solid surfacing.
 - .3 Solid surfacing: As manufactured by Caesar Stone and Silestone.
 - .4 Colours: To the later selection of the Consultant from manufacturer's standard colour range.

- .11 Engineered quartz: 93% crushed quartz combined with polyester resins and pigments formed into minimum 20 mm thick dense non-porous slabs with polished finish. Colour: To be selected by Consultant; 'CaesarStone' by CaesarStone Quartz Surfaces or approved alternative.
- .12 Laminating adhesive: CSA O112 Series, water resistant type, low VOC content, selected by laminate manufacturer for intended end use.
- .13 Draw bolts and splines: Type as recommended by fabricator.
- .14 Nails and staples: Conforming to ASTM F1667; Size and type to suit application, galvanized for exterior work, interior humid areas and for treated lumber; plain finish elsewhere.
- .15 Bolts, nuts, washers, blind fasteners, lags and screws: Size and type to suit application. Stapling is not acceptable.
- .16 Adhesive and bituminous mastic: Selected by the millwork fabricator with low VOC content.
- .17 Miscellaneous metals: In accordance with Section 05 50 00.
- .18 Glass and glazing materials: In accordance with Section 08 80 00.
- .19 Finishing: In accordance with Section 09 91 00.

2.2 **HARDWARE**

- .1 The following hardware is the minimum quality standard for the work of this Section. Alternatives may be considered provided they are approved by Consultant prior to ordering of products.
- .2 Drawer slides:
 - .1 Full extension with soft-closing feature.
 - .2 Acceptable Product:
 - .1 '8400 Series' with '8450FM Soft-Close Drawer Slide' by Knappe & Vogt.
 - .2 Or approved equivalent by Accuride or approved equivalent manufacturer.
- .3 Pilasters: Clear anodized aluminum recessed shelf standards with 12 mm divisions, Model 233 by Knappe & Vogt.
- .4 Clips: Bright zinc plated, adjustable height shelf supports, Model 256 by Knappe & Vogt.
- .5 Cabinet hinges: Heavy duty, concealed, 100 degree, clip, self closing, Model 'Blumotion' by Blum.

- .6 Piano hinge: Heavy duty, continuous, 100 mm wide piano hinge with nickel-plated finish. Provide recessed and cut to size.
- .7 Drawer and cabinet pulls: 26 mm deep x 109 mm wide, stainless steel with matt finish; CBH 245 by Canadian Builders Hardware.
- .8 Magnetic catches: Model 918 by Knappe & Vogt.
- .9 Locks: Cam locks/deadbolt locks complete with lock core by Hafele, type to suit application and installation. Provide locks in locations as indicated on drawings.
- .10 Child-Proof Locks (At All Childcare Lower Cabinets): Totlok latch door lock with magnetic key, 'T20130' And 'T20330' by Richelieu or approved alternative.
- .11 Downward-opening doors:
 - .1 Hinge: Continuous stainless steel piano hinge.
 - .2 Suspension arms: Left and right hand doors stays to hold door open or closed, soft-opening, 90 degrees, white plastic with steel stays; '28100330' by Richelieu or approved alternative.
- .12 Rectangular grommets: 240 x 120 mm, aluminum cable outlet with straight flap cover and brushed seal, with manufacturer's standard finish in colour 'Silver; '2135206100' by Richelieu or approved alternative.
- .13 Clothes hooks for childcare cubbies: Anodized aluminum with matte finish, 'Model 842.01 909' by Hafele or approved alternative.
- .14 Display cabinet system: All components required for a complete display glass system indicated on the drawings, including but not limited to the following components:
 - .1 Provide black felt with minimal seams.
 - .2 Shelf standards/brackets: 'Kaiman Glass and Wood Wall Shelf Support' in satin Nickel, by Richelieu or approved alternative.
 - .3 Track system: 'HAWA CLIPO 36 GPPK' by Richelieu or approved alternative.
 - .4 Locking mechanism for sliding glass doors: 'HAWA CLIPO 36 GPPK locking system' by Richelieu or approved alternative.
 - .5 Sliding glass doors and glass shelves to be 6 mm tempered glass.

2.3 **PLASTIC LAMINATE WORK**

- .1 Perform plastic laminate work in accordance with NAAWS and ANSI/NEMA LD 3.
- .2 Ensure adjacent parts of continuous laminate work match in colour and pattern.
- .3 Unless otherwise indicated or specified, laminate plastic laminates to veneer core plywood in accordance with manufacturer's written instructions, excluding items such as cabinet doors, drawer front components, and wall and ceiling panels which shall use moisture resistant MDF as the core substrate.

- .4 Laminate postformed laminates to MDF or particleboard core in accordance with manufacturer's written instructions.
- .5 Fabricate core surfaces and profiles with continuous support and bond over entire surface to receive plastic laminate.
- .6 Apply plastic laminate backing sheets to balance shrinkage stresses induced by plastic laminate face sheets.
- .7 Joints:
 - .1 Install joints in accordance with reviewed shop drawings.
 - .2 Jointing shall be placed at logical locations in intended millwork item and shall meet the overall aesthetic intent of the Consultant.
 - .3 Minimize joints in plastic laminate work.
 - .4 Do not install joints in plastic laminate work in less than 2400 mm o.c.
 - .5 Locate joints minimum 610 mm from cut-outs.
 - .6 Offset core and plastic laminate facing joints.
- .8 Form shaped profiles and bends as indicated, using postformed grade laminate to laminate manufacturer's instructions.
- .9 Edging to be done using 3 mm thick PVC to match plastic laminate colour to cover exposed edge of core material. Square exposed edges. Do not mitre laminate edges.
- .10 Apply laminated plastic liner sheet to interior of cabinetry and where indicated.
- .11 Fabricate units by solid surfacing manufacturer's certified or approved fabricator/installer. Fabricate built-up profiles as indicated.

2.4 **FABRICATION**

- .1 Be responsible for methods of construction and for ensuring that materials are rigidly and securely attached and will not be loosened by the work of other sections.
- .2 Coordinate locations of concealed supports and blocking with other parts of work. Provide cutouts for outlet boxes and other fixtures.
- .3 Fabricate work in a manner which will permit expansion and contraction of the materials without visible open joints. Conceal joints and connections in wherever possible.
- .4 Set nails and countersink screws, apply wood filler to indentations, sand smooth and leave ready to receive finish.
- .5 Mitre exposed corners or as shown on Architectural Drawings, no end grain shall be visible in completed installation.

- .6 Finished millwork shall be free from bruises, blemishes, mineral marks, knots, shakes and other defects and shall be selected for uniformity of colour, grain and texture.
- .7 Shelving to cabinetwork to be adjustable unless otherwise noted.
- .8 Recess shelf standards, unless noted otherwise. Stagger recessed shelf standards on opposite sides of divider.
- .9 Do not exceed maximum 760 mm unsupported span for 19 mm thick shelving. House fixed shelving into gables and divisions.
- .10 Shop assemble finish carpentry to accommodate delivery and handling and to ensure passage through building openings.
- .11 Shop install cabinet hardware for doors, shelves and drawers. Recess shelf standards unless noted otherwise.
- .12 Fabricate sills, screens, frames, and moldings to profiles shown.
- .13 Fabricate millwork cabinets of compact laminate for all millwork box (body), doors and drawers of compact laminate and all interior components such as shelves of white melamine.
- .14 Window sills:
 - .1 Provide all wood window sills where indicated and as detailed.
 - .2 Construct sills and aprons of White Oak veneer hardwood. All sills with plywood at openings are to be marine grade plywood.
 - .3 Conceal all fixings.
 - .4 Include all hardwood trim.
 - .5 Provide all solid continuous blocking and shims required for installation. (Where indicated, secure sills to steel supports.)

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Install finish carpentry work in accordance with AWS Quality Standards and tolerances for Architectural Woodwork and reviewed shop drawings.
- .2 Set and secure finish carpentry in place, rigid, plumb, square, and level.

- .3 Cut as required, fit to abutting walls, and surfaces, fit properly into recesses and to accommodate columns, fixtures, outlets, or other projecting, intersecting or penetrating objects leaving a 0.8 mm gap maximum. Typically provide reveals between millwork and wall and ceiling surfaces in accordance with Architectural details.
- .4 Coordinate cutouts for plumbing fixtures, inserts, appliances, outlet boxes, and other fixtures, in finish carpentry. Round internal corners of cut-outs and seal exposed cores.
- .5 Form joints to conceal shrinkage.
- .6 Install draw bolts and splines in compact laminate counter top joints at maximum spacing 450 mm o.c., and 75 mm from edge. Make joints flush, hairline butt joints.
- .7 Install finishing hardware accurately and securely in accordance with manufacturer's directions, adjust and clean.
- .8 Install prefinished millwork at locations shown on drawings. Position accurately, level, plumb straight.
- .9 Apply bituminous coating over wood framing members in contact with masonry or cementitious construction.
- .10 Melamine panels: Assemble melamine millwork using dowelled/wafered-and-glue construction. Installed melamine panels shall not show any exposed fasteners on finished/exposed surfaces.
- .11 Solid surfacing:
 - .1 Install solid surfacing in accordance with manufacturer's instructions.
 - .2 Align work plumb and level.
 - .3 Seal perimeter of fabrication to adjacent construction in accordance with Section 07 92 00.
- .12 Engineered quartz:
 - .1 Construct countertops of sizes and details as noted.
 - .2 Accurately and neatly cut, drill and fit stone as required for fixtures, fittings, and other appurtenances abutting or extending through stone and repair all stone after other Sections have finished.
 - .3 In cutting and fitting, the edges shall be carefully cut and ground to a perfect fit and all cutting shall be done in such a manner as not to impair the strength or appearance of the material.
- .13 Wood Panels: Install wood paneling in locations indicated on drawings. Ensure that panels are securely fastened in true vertical and horizontal manner.
- .14 Door frames:
 - .1 Butt and cope internal joints of door frames to make snug, tight, joint. Cut right angle joints with mitred joints.

- .2 Fit backs of frames snugly to wall surfaces to eliminate cracks at junction of frame with walls.
- .15 Benches:
 - .1 Construct wood benches of white oak wood veneer with stain finish of sizes and details as noted.
 - .2 Anchor wood to supports in a concealed manner.
 - .3 Keep joints to a minimum.
 - .4 Install bench brackets and supports supplied under work of Section 05 50 00.
 - .5 Apply finish under work of Section 09 91 00.
- .16 Fastening:
 - .1 Coordinate wall securement, anchorage, and blocking for finish carpentry items.
 - .2 Position items of finished carpentry work accurately, level, plumb, true and fasten or anchor securely.
 - .3 Design and select fasteners to suit size and nature of components being joined. Use proprietary devices as recommended by manufacturer.
 - .4 Provide heavy duty fixture attachments for wall mounted cabinets.
 - .5 Set finishing nails to receive filler. Where screws are used to secure members, countersink screw in round cleanly cut hole and plug with wood plug to match material being secured.
- .17 Remove and replace damaged, marked, or stained finish carpentry.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for the application of sheet waterproofing work in open-cut foundations and any additional areas indicated on Drawings in accordance with the Contract Documents.

1.2 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating characteristics, performance criteria, and limitations. Indicate preparation, installation requirements and techniques, Product storage, and handling criteria.
- .2 Shop drawings: Submit shop drawings in accordance with Section 01 33 00 indicating location and extent of system and system finish applications; system and joint sealant treatment materials, details of terminations at end of each days' work; large scale details, including relationships with adjacent construction; installation sequence and methods; connections; edge treatment at discontinuous edges; and accessories and other pertinent information required for proper and complete installations.
- .3 Samples: Submit following samples in accordance with Section 01 33 00:
 - .1 Two 300 x 300 mm samples of waterproofing membrane.
 - .2 Two samples, 300 mm long, of fastening bar.
 - .3 Two samples 300 x 300 mm of protection board.
- .4 Certification: Submit installer's certification verifying compliance with specification requirements.
- .5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.3 **QUALITY ASSURANCE**

- .1 Qualifications: Execute work of this Section by manufacturer-approved, skilled, qualified, and experienced workers, trained in installation of work of this Section.

1.4 **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.

1.5 **EXTENDED WARRANTY**

- .1 Submit an extended written warranty for sheet waterproofing work in accordance with the Conditions of the Contract, except that warranty period is extended to five (5) years from date of Contract Documents.
 - .1 Warrant work against defects including adhesive failure, cohesive failure, waterproofing failure, and water leakage.
 - .2 Coverage: Complete replacement including effected adjacent Work.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.
- .2 All components of the waterproofing system shall be supplied by one manufacturer.
- .3 Primer:
 - .1 'Aquaprime' by Henry Company Canada Inc.
 - .2 'CCW AWP' by Carlisle Coatings and Waterproofing.
 - .3 'Elastocol Stick' by Soprema.
 - .4 'Mel-Prime Primer by W. R. Meadows
- .4 Mastic:
 - .1 'Polybitume 570-05 Sealing Compound' by Henry Company Canada Inc.
 - .2 'CCW 704 Mastic' by Carlisle Coatings and Waterproofing.
 - .3 'Sopramastic 200' by Soprema
 - .4 'Pointing Mastic' by W. R. Meadows
- .5 Sheet waterproofing: 1.5 mm thick, single-ply, self adhering, self sealing, rubberised asphalt, bonded to a cross-laminated high density polyethylene film.
 - .1 'Blueskin WP 200' by Henry Company Canada Inc.
 - .2 'CCW Miradri 860/861' by Carlisle Coatings and Waterproofing.
 - .3 'Colphene 3000' by Soprema
 - .4 'Mel-Rol' by W. R. Meadows
- .6 Fastening bar: Continuous 25 mm wide x 3 mm thick aluminum bar, predrilled for mechanical attachment.
- .7 Protection Board:
 - .1 '990-31' by Henry Company Canada Inc.
 - .2 'CCW Protection Board - V' by Carlisle Coatings and Waterproofing.
 - .3 'Sopraboard' by Soprema Inc.
 - .4 'Sealtight Vibraflex Waterproofing Protection Board' by W. R. Meadows.
- .8 Accessories: As recommended by waterproofing system manufacturer.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify that existing substrates to receive waterproofing are clean, dry, sound, smooth, and continuous.
- .3 Coordinate sealing of interruptions in, and protrusions through waterproofing membrane. Verify that other work items projecting through waterproofing membrane are in place and are securely installed.

3.2 **MASTIC AND PRIMER**

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

3.3 **WATERPROOFING**

- .1 Install mastic where required to ensure integrity of waterproofing installation at protrusions and other complex details.
- .2 Install waterproofing in accordance with manufacturer's instructions.
- .3 Lap waterproofing ends and edges 50 mm minimum. Roll waterproofing and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.
- .4 Extend waterproofing as required to connect to other components of work comprising waterproofing system.
- .5 Cut and fit waterproofing 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 waterproofing assembly, to prevent loss of adhesion and damage waterproofing.
- .7 Supply and install continuous mechanical fastening bar to clamp waterproofing both sides of unfilled gaps, cracks, and joints.

- .8 Supply and install protection board in accordance with detailed system, and manufacturer's instructions.

3.4 REPAIR

- .1 Repair misaligned or inadequately lapped seams, punctures, or other damage with additional ply of waterproofing sized to extend 150 mm minimum in all directions from repair edge.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products equipment and services necessary for fluid applied waterproofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM D41/D41M, Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit manufacturer's Product data in accordance with the Conditions of the Contract indicating installation details, physical properties and detailed application and installation instructions, marked as applicable to Work.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Adjacent construction and typical details, dimensions, thickness, method of attachment, protection and penetration details.
 - .2 Location of each membrane penetration.
- .3 Samples:
 - .1 Submit the following samples in accordance with Section 01 33 00. Submit two samples of the following:
 - .1 Each type of waterproofing membrane, 300 x 300 mm.
 - .2 Each type of reinforcing membrane, 300 x 300 mm.
 - .3 Protection board and filter fabric, 300 x 300 mm.
- .4 Certificates:
 - .1 Submit certifications for items required at least 8 weeks prior to installation of work of this Section.
 - .2 Submit manufacturer's certification that waterproofing system materials and accessories supplied are compatible, meet Specification requirements and that installer is approved by membrane manufacturer.
 - .3 Submit manufacturer's certification that waterproofing components are approved for use as complete waterproofing system.
 - .4 Submit Contractor's certification that waterproofing installers and quality control supervisors meet Specification requirements. Submit names of successful membrane installations in which certified personnel have performed tasks of comparable complexity and scope within preceding 5 years.
 - .5 Submit inspection reports and certification by manufacturer confirming that installations are in accordance with manufacturer's requirements.
- .5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 **QUALITY ASSURANCE**

- .1 Installer's qualifications: Perform work of this Section by company, approved by Product manufacturer and having 5 years recent experience in work of comparable complexity and scope.
- .2 Mock-up:
 - .1 Construct one 3 m² mock-up of waterproofing system in a location acceptable to the Consultant. Show stages of application.
 - .2 Demonstrate one lap joint, one inside corner, and one outside corner.
 - .3 Obtain Consultant's acceptance. Accepted mock-up may become part of the Work. Mark mock-up to Consultant's acceptance and match remainder of work to accepted mock-up. Remove unacceptable mock-up.
- .3 Pre-installation meeting: Arrange with manufacturer's representative to inspect substrates and review installation procedures 48 hours in advance of installation.

1.5 **SITE CONDITIONS**

- .1 Maintain air temperature and structural base temperature at waterproofing installation area above 5°C for 24 h before, during and 24 hr after installation.
- .2 Do not apply waterproofing in wet weather.
- .3 Ventilate area by forced air circulation during installation and curing periods for enclosed applications.

1.6 **EXTENDED WARRANTY**

- .1 Submit an extended written warranty for fluid applied waterproofing in accordance with the General Conditions, except that warranty period is extended to 10 years from date of Substantial Performance.
 - .1 Warrant work against water leakage and failure to stay in place.
 - .2 Coverage: Complete replacement including effected adjacent Work.

2 **Products**

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.
- .2 Use products by only one manufacturer throughout work of this Section.
- .3 Primer: conforming to ASTM D41/D41M;
 - .1 'CCW 550' by Carlisle Coatings and Waterproofing.
 - .2 '930-18' by Henry Company Canada.
 - .3 'Surface Conditioner' by Hydrotech Membrane Corporation.

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- .4 'Tremprime 6100' by Tremco.
 - .4 Membrane reinforcement (standard duty):
 - .1 'CCW Uncured Neoprene' by Carlisle Coatings and Waterproofing.
 - .2 'ModifiedPLUS NP180p/p' by Henry Company Canada.
 - .3 'Flex Flash F' by Hydrotech Membrane Corporation.
 - .4 'Elastomeric Sheeting' by Tremco.
 - .5 Membrane reinforcement (heavy duty):
 - .1 'CCW 711-90' by Carlisle Coatings and Waterproofing.
 - .2 'ModifiedPLUS NP180p/p' by Henry Company Canada.
 - .3 'Flex Flash UN' by Hydrotech Membrane Corporation
 - .4 'Butyl Sheeting' by Tremco.
 - .6 Securement bar: Continuous 25 mm wide x 3 mm thick aluminum bar, predrilled for mechanical attachment.
 - .7 Fabric reinforcement:
 - .1 'Reinforcing Fabric' by Carlisle Coatings and Waterproofing.
 - .2 'Polyester Reinforcing Fabric' by Henry Company Canada.
 - .3 'Flex Flash F' by Hydrotech Membrane Corporation.
 - .4 'Reinforcing Fabric (2014)' by Tremco.
 - .8 Waterproofing membrane: One-part, 100% solids, rubberized asphalt.
 - .1 'CCW 500' by Carlisle Coatings and Waterproofing.
 - .2 '790-11' by Henry Company Canada.
 - .3 'Monolithic Membrane 6125' by Hydrotech Membrane Corporation.
 - .4 'Tremproof 6100' by Tremco.
 - .9 Protection board (Polypropylene):
 - .1 'CCW Protection Board V' by Carlisle Coatings and Waterproofing.
 - .2 '990-31' by Henry Company Canada.
 - .3 'Hydroshield Protection Board' by Hydrotech Membrane Corporation.
 - .4 'Tremco 2450' by Tremco.
 - .10 Protection board (Asphaltic):
 - .1 'CCW Protection Board H' by Carlisle Coatings and Waterproofing.
 - .2 'Asphalt Protection Board' by Henry Company Canada.
 - .3 'Tremco 2550/2560' by Tremco.
 - .4 Or approved alternative by Hydrotech Membrane Corporation to suit asphaltic application.
 - .11 Protection Sheet: Reinforced modified bituminous membrane as recommended by manufacturer.
 - .12 Separation sheet: 0.2 mm thick minimum, polyethylene sheet.
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3 Execution

3.1 **EXAMINATION**

- .1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Have manufacturer's authorized representative verify that conditions are acceptable for installation of membrane waterproofing.

3.2 **SUBSTRATE PREPARATION AND PROTECTION**

- .1 Allow concrete substrates to cure minimum of 14 days prior to surface preparation.
- .2 Ensure that form tie holes, honeycombed areas, and other voids and holes which may impair performance of waterproofing membrane, are filled flush and are dry.
- .3 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and foreign matter detrimental to the adhesion of the hot rubberized asphalt.
- .4 Remove debris from deck, blow substrate surfaces clean using oil-free compressed air.
- .5 Abrasive blast (track blast) concrete surfaces to be waterproofed to profile required by waterproofing manufacturer.
- .6 Prohibit traffic, on prepared areas to be waterproofed, until work of this Section is completed.
- .7 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.

3.3 **PRIMER**

- .1 Prime substrate surfaces in accordance manufacturer's instructions.
- .2 Apply primer uniformly as a fine spray at a rate 10 m²/l [490 ft²/gal]; prevent overspray and ponding of primer. Allow primer to dry fully before applying waterproofing membrane.

3.4 **REINFORCEMENT GENERAL**

- .1 Fabric and membrane reinforcing sheets:
 - .1 Overlap 150 mm at end laps and seal with waterproofing membrane.
 - .2 Prevent wrinkles and fishmouths.
 - .3 Wrap outside horizontal and vertical corner with 150 mm membrane reinforcement embedded in waterproofing membrane.

- .4 Supply and install heavy duty membrane reinforcement at drains and protrusions.

3.5 **CRACK AND JOINT TREATMENT**

- .1 Horizontal substrate cracks and joints, under 3 mm wide including control joints:
 - .1 Seal with 150 mm wide, continuous fabric reinforcing embedded into 3 mm thick, 300 mm wide strip coating of waterproofing membrane. Centre fabric reinforcing on crack or joint and extend both waterproofing membrane and fabric reinforcing minimum 50 mm beyond end of crack or joint.
- .2 Horizontal substrate cracks and joints, over 3 mm wide (excluding expansion joints):
 - .1 Seal with 150 mm wide, continuous membrane reinforcing embedded into 3 mm thick, 300 mm wide strip coating of waterproofing membrane. Centre membrane reinforcement on crack or joint and extend both waterproofing membrane and membrane reinforcing minimum 50 mm beyond end of crack or joint.
- .3 Horizontal to vertical junctures and vertical construction joints:
 - .1 Seal with 300 mm wide, continuous membrane reinforcing embedded into 3 mm thick, 450 mm wide strip coating of waterproofing membrane. Centre membrane reinforcing on juncture extending 150 mm onto both horizontal and vertical surfaces. Supply and install continuous fastening bar along top edge of membrane reinforcement.
- .4 Horizontal to vertical junctures and vertical control joints (excluding expansion joints):
 - .1 Seal with 400 mm wide, continuous heavy duty membrane reinforcing embedded into 3 mm thick, 550 mm wide strip coating of waterproofing membrane. Centre heavy duty membrane reinforcing on juncture extending 200 mm onto both horizontal and vertical surfaces. Supply and install continuous fastening bar along top edge of heavy duty membrane reinforcement.

3.6 **EXPANSION JOINTS**

- .1 Horizontal:
 - .1 Seal with 400 mm wide, continuous heavy duty membrane reinforcing looped 1.5 x joint width and embedded into 3 mm thick, 550 mm wide strip coating of waterproofing membrane.
 - .2 Centre heavy duty membrane reinforcing on expansion joint extending 150 mm minimum onto both surfaces.
 - .3 Supply and install joint backing and waterproof membrane to fill loop to flush.
- .2 Vertical:
 - .1 Seal with 400 mm wide, continuous heavy duty membrane reinforcement looped 1.5 x joint width and embedded into 3 mm thick, 550 mm wide strip coating of waterproofing membrane.
 - .2 Centre heavy duty membrane reinforcement on expansion joint extending 150 mm minimum onto both surfaces.

- .3 Horizontal to vertical junctures:
 - .1 Seal with 500 mm wide, continuous heavy duty membrane reinforcing embedded into 3 mm thick, 550 mm wide strip coating of waterproofing membrane.
 - .2 Centre heavy duty membrane reinforcing on juncture extending 200 mm onto both horizontal and vertical surfaces. Supply and install continuous fastening bar along top edge of heavy duty membrane reinforcement.

3.7 **WATERPROOFING MEMBRANE**

- .1 Install waterproofing membrane in accordance with accepted shop drawings and manufacturer's instructions.
- .2 Use manufacturer's recommended installation equipment and carefully monitor waterproofing membrane kettle temperatures.
- .3 Install first layer of waterproofing membrane to a uniform minimum thickness of 2 mm and an average of 3 mm, forming a continuous monolithic coating over horizontal and vertical surfaces.
- .4 Embed fabric reinforcement into hot membrane, overlap fabric 50 mm, ensure one layer of waterproofing membrane between overlaps.
- .5 Install second layer of waterproofing membrane to minimum thickness of 3 mm for total membrane thickness of 5-6 mm minimum.
- .6 Reinforce corners with 2 plies of fabric reinforcement, overlap sides and ends 100 mm.

3.8 **PROTECTION BOARD AND SEPARATION SHEET**

- .1 Supply and install protection board or separation sheet in accordance with detailed system, and manufacturer's instructions.

3.9 **FIELD QUALITY CONTROL**

- .1 Coordinate inspection and testing of fluid applied waterproofing with Consultant.
- .2 Temporarily plug drains and dam horizontal surface areas to be tested. Flood with water to minimum depth of 80 mm. Maintain flooded depth for 24 h. Have manufacturer's representative and Consultant witness test.
- .3 If leaks occur repair in accordance with manufacturer's instructions and retest.

3.10 PROTECTION

- .1 Supply and install temporary protection and barricades to prevent mechanical damage or contamination such as oils or solvents, until waterproof membrane assembly is covered by subsequent parts of Work.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for the application of fluid applied waterproofing at storm water tank in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM C836, Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Materials list of items to be provided under this Section.
 - .2 Manufacturer's specifications and other data needed to ensure compliance with the specified requirements including but not limited to installation details and physical properties.
 - .3 Manufacturer's current recommended installation procedures.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Materials, adjacent construction and typical details, dimensions, thickness, crack and joint treatment, method of attachment, protection and penetration details and relationship to adjacent construction..
 - .2 Location of each membrane penetration.
- .3 Certificates:
 - .1 Submit certifications for items required at least 4 weeks prior to installation of Work of this Section.
 - .2 Submit manufacturer's certification that waterproofing system materials and accessories supplied are compatible, meet Specification requirements and that installer is approved by membrane manufacturer.
 - .3 Submit inspection reports, within 3 working days after each inspection, and certification by manufacturer confirming that installations are in accordance with manufacturer's requirements.
- .4 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 QUALITY ASSURANCE

- .1 Installers qualifications: Perform Work of this Section by a company that has a minimum of five years proven experience in the installation of fluid applied waterproofing of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Mock-up:
 - .1 Construct one 3 m² mock-up of waterproofing in location acceptable to Consultant.
 - .2 Demonstrate as a minimum one inside corner, surface preparation, and typical installation.
 - .3 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with Work.
 - .4 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
 - .5 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.
- .3 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials to job site in manufacturer's unopened containers with all labels intact and legible at time of use.
- .2 Maintain the products in accord with manufacturer's recommendations with proper precautions to ensure fitness of material when installed.

1.6 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 are below: 5 °C.
 - .2 Precipitation: None.
- .2 Ensure that temperature of substrate and its moisture content conforms to manufacturer's minimum requirements, before proceeding with work.
- .3 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 24 hours before, during, and 24 hours after installation.

1.7 **EXTENDED WARRANTY**

- .1 Submit an extended written warranty for concrete tank waterproofing in accordance with the General Conditions, except that warranty period is extended to 5 years from date of Contract Documents.
 - .1 Warrant Work against defects including adhesive failure, cohesive failure, waterproofing failure, and water leakage.
 - .2 Coverage: Complete replacement including effected adjacent Work.

2 Products

2.1 **MATERIALS**

- .1 Concrete tank waterproofing system: ASTM C836, One-part moisture curing elastomeric, rapid-curing, high solids, VOC compliant modified polyurethane waterproofing membrane system for storm water tank complete with reinforcing. 'TREMproof 250GC' by Tremco Commercial Sealants and Waterproofing or approved alternative.
- .2 Primer, sealants and additional accessories: As recommended by waterproofing system manufacturer.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.
- .2 Verify that existing substrates to receive waterproofing are clean, dry, sound, smooth, and continuous.

3.2 **PREPARATION**

- .1 Allow concrete substrates to cure 24 to 48 hours prior to surface preparation.
- .2 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and foreign matter detrimental to the adhesion of the hot rubberized asphalt.
- .3 Clean all surfaces to receive membrane system in accord with manufacturer's instructions; vacuum clean or blow clean with oil-free compressed air all surfaces to receive waterproofing membrane and accessories. Protect adjacent surfaces not being waterproofed.

- .4 Rout, clean, prepare and detail surface cracks form tie holes, honeycombed areas, and other voids and holes which may impair performance of waterproofing membrane in accordance with manufacturer's instructions; install backer rod where required.
- .5 Clean metal surfaces to bright metal by wire brushing or mechanical etching; scuff-sand lead flashing and plastic surfaces.
- .6 Install detail cants, detail coats, joint and crack treatments, and liquid flashings in accord with manufacturer's instructions.
- .7 Allow detail applications to cure in accord with manufacturer's instructions prior to general application of membrane.
- .8 Prime surfaces in accord with manufacturer's instructions.
- .9 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from Work of this Section.
- .10 Coordinate sealing of interruptions in, and protrusions through waterproofing membrane. Verify that other Work items projecting through waterproofing membrane are in place and are securely installed.

3.3 **INSTALLATION**

- .1 Apply primer, sealant and bond breaker tape in accordance with manufacturer's instructions.
- .2 Install waterproofing in locations indicated on drawings. Continue membrane up wall to a minimum of 150 mm above final grade line or previously determined elevation.
- .3 All shrinkage cracks to be treated with 1.5 mm coating of waterproofing, 150 mm wide centred over cracks.
- .4 Grid surfaces to assure proper coverage rates and verify membrane wet-film mil thickness with gauges as work progresses.
- .5 Roller, squeegee, or trowel apply fluid waterproofing membrane in accordance with manufacturer's written instructions and ASTM C836 to provide the following minimum thicknesses:
 - .1 Horizontal surfaces: 3.0 mm.
 - .2 Vertical surfaces: 2.3 mm.
- .6 Install a 25 mm cant of waterproofing at all horizontal-vertical junctures and projections.
- .7 Ensure complete coverage to substrate, around flashings and protrusions and at changes in direction of surface. Work material into any fluted rib forming indentations.

- .8 Extend waterproofing as required to connect to other components of Work comprising waterproofing system.
- .9 When applying waterproof membrane, work membrane material well into surface of the concrete, filling surface pores and hairline cracks.

3.4 **PROTECTION**

- .1 Supply and install temporary protection and barricades to prevent mechanical damage or contamination such as oils or solvents, until waterproof membrane assembly is covered by subsequent parts of Work.

3.5 **FIELD QUALITY CONTROL**

- .1 Flood test:
 - .1 Do not conceal waterproofing until inspection and testing are completed to satisfaction of Consultant.
 - .2 Temporarily plug drains and dam horizontal surface areas to be tested and flood with water to minimum depth of 50 mm.
 - .3 Maintain flooded depth for 24 hours.
 - .4 If leaks occur repair and retest.
 - .5 Remove water at end of test.

3.6 **CLEANING**

- .1 Clean to Consultant's approval, soiled surfaces, spatters, and damage caused by work of this Section.
- .2 Check area drains to ensure cleanliness and proper function, and remove debris, equipment and excess material from site.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for the application of cementitious waterproofing work at the interior floor and walls of elevator pit(s) in accordance with the Contract Documents.

1.2 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, installation details, physical properties, detailed application and installation instructions, and limitations.
 - .2 Product transportation, storage, and handling requirements.
 - .2 Shop drawings: Submit shop drawings in accordance with Section 01 33 00 indicating materials, details, dimensions, thickness, treatment of joints and cracks, protection, penetration details, and relationship to adjacent construction.
 - .3 Certificates:
 - .1 Submit certifications for items required at least 4 weeks prior to installation of work of this Section.
 - .2 Submit manufacturer's certification that waterproofing system materials and accessories supplied are compatible, meet Specification requirements and that installer is approved by membrane manufacturer.
 - .3 Submit inspection reports, within 3 working days after each inspection, and certification by manufacturer confirming that installations are in accordance with manufacturer's requirements.
 - .4 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.3 **QUALITY ASSURANCE**

- .1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of cementitious waterproofing of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Cementitious waterproofing system shall be tested in accordance with the following standards and conditions, and the testing results shall meet or exceed the performance requirements as specified herein:
 - .1 Independent Laboratory: Testing shall be performed by an independent laboratory meeting the requirements of the Standards Council of Canada. Testing laboratory shall obtain all concrete samples and water proofing product samples.

- .2 Crystalline Penetration: Crystallizing capability of waterproofing material shall be evidenced by independent SEM (Scanning Electron Microscope) photographs documenting penetration of crystal-forming waterproofing material to a depth of 50 mm.
- .3 Permeability:
 - .1 Independent testing shall be performed according to U.S. Army Corps of Engineers CRD C48-73 "Permeability of Concrete".
 - .2 Concrete samples (treated and untreated) to have design strength of 13.8 MPa and thickness of 50 mm. No admixtures permitted.
 - .3 Coatings to have maximum thickness of 1 mm per coat with up to two coats permitted.
 - .4 Samples to be pressure tested to 1.2 MPa (121.5 m head of water).
 - .5 Treated samples, after crystalline growth has occurred, shall exhibit no measurable leakage.
- .4 Chemical Resistance:
 - .1 Independent testing shall be performed according to ASTM C267 "Chemical Resistance of Mortars" and ASTM C39 "Compressive Strength of Cylindrical Concrete Specimens".
 - .2 Concrete samples (treated and untreated) to have design strength of 27.6 MPa. No admixtures permitted.
 - .3 Coatings to have maximum thickness of 1 mm per coat with up to two coats permitted.
 - .4 Untreated and treated specimens to be immersed for a minimum of 84 days in following chemical solutions: hydrochloric acid (3.5pH), brake fluid, transformer oil, ethylene glycol, toluene, caustic soda.
 - .5 Treated specimens shall exhibit no detrimental effects after exposure, and shall have a minimum of 14% increase in compressive strength versus untreated control specimens.
 - .6 Potable Water Approval: Independent testing shall be performed according to NSF Standard 61 and approval for use of waterproofing material on structures holding potable water shall be evidenced by NSF certification.
- .3 Mock-up:
 - .1 Construct one 3 m² mock-up of waterproofing in location acceptable to Consultant.
 - .2 Demonstrate as a minimum one inside corner, one outside corners, surface preparation, and typical installation.
 - .3 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
 - .4 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
 - .5 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.
- .4 Pre-installation meetings:
 - .1 Arrange with manufacturer's representative and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.4 **DELIVERY, STORAGE, AND HANDLING**

- .1 Store packaged materials in original undamaged containers with manufacturers labels and seals intact, in dry enclosed area, off the ground. Prevent damage of materials during handling and storage.
- .2 Handle and store materials in accordance with manufacturers written instructions.

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 are below: 5°C.
 - .2 Precipitation: None.
- .2 Ensure that temperature of substrate and its moisture content conforms to manufacturer's minimum requirements, before proceeding with work.
- .3 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 24 hours before, during, and 24 hours after installation.

1.6 **EXTENDED WARRANTY**

- .1 Submit an extended warranty for cementitious waterproofing work in accordance with the General Conditions of the Contract, except that warranty period is extended to five years from date of Contract Documents.
 - .1 Warrant work against leakage.
 - .2 Coverage: Complete replacement including affected adjacent Work.

2 **Products**

2.1 **MATERIALS**

- .1 Cementitious Waterproofing system: Furnish a waterproofing system comprising of cement quartz and other non-toxic chemicals, and additives which, on contact with moisture, produce a crystalline growth throughout the capillary voids in the concrete. 'MasterSeal 500' by Master Builders Solutions, 'Permaquik Crystalline Waterproofing' by Tremco, 'Cem-Kote CW Plus' by W.R. Meadows or equivalent product(s) by Xypex Chemical Corporation.

2.2 **MIXES**

- .1 Mix waterproofing material, by volume with clean water free from salt and deleterious materials, to the required proportions and consistency in accordance with manufacturer's written recommendations to achieve.
- .2 Mix waterproofing material in quantities that can be applied within 20 to 30 minutes from time of mixing.

- .3 As mixture thickens, stir frequently, but do not add additional water. Do not mix bonding agents or admixtures with cementitious waterproofing materials.

3 Execution

3.1 EXAMINATION

- .1 Verify that concrete surfaces are sound and clean, and that form release agents and materials used to cure the concrete are compatible with waterproofing treatment.
- .2 Examine surfaces to be waterproofed for form tie holes and structural defects such as honeycombing, rock pockets, faulty construction joints and cracks. Such defects to be repaired in accordance with manufacturer's written instructions.
- .3 Verify condition and dimensions of previously installed work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 PREPARATION

- .1 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.
- .2 Concrete surfaces to receive waterproofing shall have an open capillary system to provide tooth and suction, and shall be free from scale, excess form oil, laitance, curing compounds and foreign matter.
- .3 Smooth surfaces or surfaces covered with excess form oil or other contaminants shall be washed, lightly sand-blasted, water-blasted, or acid etched with muriatic acid as necessary to provide a clean absorbent surface. Surfaces to be acid-etched shall be saturated with water prior to application of acid.
- .4 Surface defects shall be repaired in accordance with manufacturer's instructions and as follows:
 - .1 Form Tie Holes, Construction Joints, Cracks: Chip out defective areas in a "U" shaped slot 25 mm wide and a minimum of 25 mm deep. Clean slot of debris and dust. Soak area with water and remove excess surface water. fill the foregoing with material suited for the purpose by the material manufacturer and finish flush to wall.
 - .2 Rock Pockets, Honeycombing or Other Defective Concrete: Rout out defective areas to sound concrete. Remove loose materials and saturate with water. Remove excess surface water and fill with material suited for the purpose by the material manufacturer and finish flush to wall.

- .3 Prior to application of waterproofing treatment, thoroughly saturate concrete surfaces with clean water as required to ensure migration of crystalline chemicals into voids and capillary tracts of the concrete. Remove free surface water before application.

3.3 **INSTALLATION**

- .1 Install cementitious waterproofing in accordance with reviewed shop drawings and manufacturer's written instructions.
- .2 Construction Joints: Apply waterproofing in slurry form at a minimum rate of 1.0 kg/m² to joint surfaces between concrete pours. Moisten surfaces prior to slurry application. Where joint surfaces are not accessible prior to pouring new concrete, consult manufacturer for application procedure.
- .3 Walls:
 - .1 Apply waterproofing uniformly to concrete surfaces with semi-stiff bristle brush or broom, or suitable spray equipment.
 - .2 Apply waterproofing in 2 coats to a minimum application rate of 1.0 kg/m².
 - .3 When brushing, work slurry well into surface of the concrete, filling surface pores and hairline cracks. When spraying, hold nozzle close enough to ensure that slurry is forced into pores and hairline cracks.
- .4 Slabs:
 - .1 Remove ponding water on slab and allow concrete to dry to a damp appearance.
 - .2 Over freshly floated concrete, broadcast waterproofing material dry onto concrete at time in initial set at a minimum rate of 1.0 kg/m². Float and then machine trowel concrete to a smooth, level and dense surface. Free from trowel marks, ridges, pinholes, and other defects.
 - .3 If it is not possible to broadcast waterproofing onto slab, waterproofing can be installed in slurry form. Application would be similar to wall application specified herein.

3.4 **CURING**

- .1 Begin curing as soon as waterproofing has hardened sufficiently so as not to be damaged by a fine spray. Cure waterproofing with a mist fog spray of clean water three times a day for 2 to 3 days, or cover treated surfaces with damp burlap for the prescribed period. In warm climates, more than three sprayings per day may be necessary to prevent excessive drying of coating.
- .2 During the curing period, protect treated surfaces from damage by wind, sun, rain and temperatures below 2°C. If plastic sheeting is used for protection, it must be raised off of waterproofing coating to allow sufficient air circulation.

3.5 FIELD QUALITY CONTROL

- .1 Flood test:
 - .1 Do not conceal waterproofing until inspection and testing are completed to satisfaction of Consultant.
 - .2 Temporarily plug drains and dam horizontal surface areas to be tested and flood with water to minimum depth of 50 mm.
 - .3 Maintain flooded depth for 24 hours.
 - .4 If leaks occur repair and retest.
 - .5 Remove water at end of test.

3.6 CLEANING

- .1 Clean to Consultant's approval, soiled surfaces, spatters, and damage caused by work of this Section.
- .2 Check area drains to ensure cleanliness and proper function, and remove debris, equipment and excess material from site.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for self-adhering sheet blind-side waterproofing work in accordance with the Contract Documents.

1.2 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s), physical properties, characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Location and extent of system, typical layouts, corner details, and special details, joint treatment, details of terminations, method of attachment, connections, edge treatment at discontinuous edges, treatment at tie-backs, and accessories and other pertinent information required for proper and complete installations.
 - .2 Large scale details, including relationships with adjacent construction, installation sequence, and methods.
 - .3 Final configuration, sequence, method of attachment to excavation support system, means and methods of supporting membrane externally or internally which will not puncture or injure membrane, and which will prevent sagging or loss of contact with excavation support system.
 - .3 Samples:
 - .1 Submit duplicate 300 x 300 mm samples of the following in accordance with Section 01 33 00.
 - .1 Waterproofing membrane.
 - .2 Tie-back head cover and accessories.
 - .3 Waterproofing accessories.
 - .4 Certificates and reports:
 - .1 Submit manufacturer's certification that waterproofing system materials and accessories supplied are compatible and meet Specification requirements.
 - .2 Submit written certification that installer has current Approved Applicator status with waterproofing material manufacturer.
 - .3 Submit names of successful membrane installations in which certified personnel have performed tasks of comparable complexity and scope within preceding 5 years.
 - .4 Submit inspection reports and certification by manufacturer confirming that installations are in accordance with the Contract Documents and manufacturer's requirements.

- .5 Submit Quality Control Plan detailing quality control procedures to be used to meet manufacturer and Specification requirements. Obtain acceptance of Quality Control Plan from Commission's Representative before starting the work of this Section.
- .5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.3 **QUALITY ASSURANCE**

- .1 Perform work of this Section by a company that has a minimum of 5 years proven acceptable waterproofing experience on installations of similar complexity and scope.
- .2 Ensure membrane manufacturer's representative has full access to this work for proper inspection prior to and during membrane installation. Provide inspection reports by manufacturer's representative confirming that installations are in accordance with Product requirements.
- .3 Mock-up:
 - .1 Construct one 3 m² mock-up of waterproofing system in location acceptable to Consultant. Show stages of application and demonstrate performance.
 - .2 Obtain Consultant's acceptance. Accepted mock-up may become part of Work. Mark mock-up to Consultant's acceptance and match remainder of work to accepted mock-up. Remove unacceptable mock-up.
- .4 Pre-installation meeting: Five days in advance of waterproofing work, arrange meeting on Site to be attended by Consultant, Contractor, waterproofing manufacturer's representative, and any other parties directly affecting the work of this Section to:
 - .1 Review methods and procedures related to waterproofing installation, including manufacturer's written instructions.
 - .2 Examine substrate conditions and finishes for compliance with manufacturer's requirements.
 - .3 Review lap and termination details, special waterproofing details, tie-back details, penetrations, and condition of other construction that will affect waterproofing work.
 - .4 Document proceedings, including corrective measures or actions required, and furnish copy of record to each participant.
- .5 Water Sample Test: Waterproofing contractor shall supply project site water sample to waterproofing membrane manufacturer for analysis. Manufacturer shall conduct test free of charge. waterproofing contractor is responsible for collection and shipment of one liter of actual site water. Water should be shipped in uncontaminated, sealed plastic container to waterproofing membrane manufacturer's testing facility. Also provide project name, city and province along with return address to forward test results.

1.4 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver materials as factory packaged, sealed and labelled. Handle and protect as necessary to prevent damage or deterioration during shipment, handling and storage. Store materials in a dry location secure from weather and construction operations. Remove damaged materials from the site and dispose of in accordance with applicable regulations.

1.5 **SITE CONDITIONS**

- .1 Perform work only when existing and forecasted weather conditions are within the guidelines established by the waterproofing membrane manufacturer. Do not apply waterproofing materials in areas of standing or active water; or over ice and snow. Maintain site conditions dry and remove standing water from precipitation or ground water seepage in a timely manner.

1.6 **EXTENDED WARRANTY**

- .1 Submit an extended written warranty for bentonite waterproofing in accordance with the General Conditions, except that warranty period is extended to 5 years from date of Substantial Performance.
 - .1 Warrant work against water leakage and failure to stay in place.
 - .2 Coverage: Complete replacement including effected adjacent Work.

2 Products

2.1 **MATERIALS**

- .1 General:
 - .1 All materials under work of this Section, including but not limited to, adhesives and grouts are to have low VOC content limits.
 - .2 Use products of only one manufacturer for the work of this Section.
 - .3 Waterproofing system to be complete with all components and accessories as required for complete and water tight installation including but not limited to membrane, tapes, mastics, fasteners, etc.
- .2 EPDM sheet waterproofing membrane:
 - .1 Self-healing, self-sealing, self-repairing, co-extruded sheet waterproofing membrane, consisting of an EPDM watertight barrier layer, hydro-reactive polymer core layer, EPDM derivative/polymer hydro-reactive layer, and a non-woven geotextile facing; having the following minimum characteristics:
 - .1 Resistance to hydrostatic head in accordance with ASTM D5385: Pass at 70 m (231 ft).
 - .2 Low temperature flexibility in accordance with ASTM D1970: Unaffected/passed at -20°F.
 - .3 Tensile strength in accordance with ASTM D412: 6.4 Mpa (927 psi).
 - .4 Puncture strength in accordance with ASTM E154: 694N (156 lbf).
 - .2 EPDM sheet waterproofing, 'TREMproof Amphibia' by Tremco Ltd. or approved alternative by Soprema.

- .3 Flashing membrane: Self-adhering flashing membrane consisting of a laminate of bentonite applied to mesh with pressure sensitive adhesive on one side; used as detailing around penetrations and grade terminations; 'Paraseal Parastick N Dry' by Tremco Ltd. or approved alternative.
- .4 Granular Material: Wyoming-type, high swelling, granular sodium bentonite product. 'Paraseal Paragranular' by Tremco Ltd. or approved alternative.
- .5 Primers, tapes, mastics, sealants and fasteners:
 - .1 Types as recommended by waterproofing membrane manufacturer.
 - .2 Primer: Type as recommended by manufacturer to suit application conditions.
 - .3 Tapes: Safety and grip tapes as recommended by manufacturer.
 - .4 Mastics and sealants:
 - .1 Mastics:
 - .1 Type 1: Hydro-reactive mastic for sealing and waterproofing passing bodies and cracks; 'Ultraseal P-201A Hydro-Reactive Mastic' by Tremco Ltd. or approved alternative.
 - .2 Type 2: Expandable mastic, 'Paraseal Paramastic' by Tremco Ltd. or approved alternative.
 - .2 Sealant: ASTM C920, Type S, Grade NS, Class 50, polyurethane sealant, 'Dymonic 100' by Tremco Ltd. or approved alternative.
- .6 Termination Bar: Aluminum termination bar with pre-punched holes for fastening; 'Paraterm Bar' by Tremco Ltd. or approved alternative.
- .7 Drainage board: Three-dimensional dimpled core and geotextile fabric complete with adhesive or fasteners as required for installation. 'TREMDrain 6000' by Tremco Inc. or approved alternative.

3 Execution

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Have manufacturer's authorized representative verify that conditions are acceptable for installation of membrane waterproofing, including installation of reinforcement and pouring of concrete.

3.2 PREPARATION

- .1 Remove dirt, debris, oil, grease, cement laitance, or other foreign matter which will impair or negatively affect the performance of the waterproofing and drainage system.

- .2 Protect adjacent work areas and finish surfaces from damage or contamination from waterproofing products during installation operations.
- .3 Concrete surfaces are to be free of large voids or projections. Voids and pits in excess of 6 mm diameter, cracks and joints shall be parged to flush condition using either cement grout or acceptable sealer. Projections greater than 6 mm shall be smoothed flush. Form-tie holes shall be filled completely with non-shrink cementitious grout.
- .4 Where below grade expansion joints between 50 mm - 125 mm in width are required, provide expansion joint prior to installation of waterproofing system. Expansion joint to be installed in accordance with manufacturers written recommendations.

3.3 **MEMBRANE INSTALLATION**

- .1 Install waterproofing membrane vertically or horizontally oriented in accordance with reviewed shop drawings and manufacturer's written instructions to provide a continuous waterproofing membrane. Installation instruction specified herein are not complete and shall be supplemented with manufacturer's written installation instructions.
- .2 Drainage board: Install drainage board in accordance with reviewed shop drawings, and manufacturer's recommendations. Drainage board shall extend full height of foundation wall to top of footing when concrete is poured in place. Position board with filter fabric side toward soil/drainage side and attach to excavation support system using manufacturer approved fastening system.
- .3 EPDM sheet waterproofing installation:
 - .1 On shoring walls, install membrane with minimum 100 mm sheet edge overlaps. Tack membrane to highest point of shoring. All overlaps of waterproofing membrane must be treated in accordance with manufacturer's written instructions and details.
 - .2 Penetrations: Install waterproofing system in accordance with manufacturer's written instructions and details for all pipe, rebar, structural and other penetrations.
 - .3 Flashings: Install membrane flashings with overlapped edges to form a continuous flashing. Install in locations indicated and where required by membrane manufacturer for a complete waterproofing membrane installation.
 - .4 Install termination bar at grade level locations in accordance with manufacturer's instructions.
 - .5 Inspect finished waterproofing installation and repair any damaged material prior to start of subsequent work.

3.4 **FIELD QUALITY CONTROL**

- .1 Arrange for daily inspection of waterproofing system installation by manufacturer's representative.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for water repellent sealer work in accordance with the Contract Documents.
- .2 Water repellent sealer to be applied on concrete slabs on grade of parking garages and any additional areas as indicated.
- .3 It is the intent of this Section to establish a single, competent source to be responsible for providing a complete, durable, weather resistant sealer and sealant that will prevent water penetration and concrete deterioration.

1.2 **REFERENCES**

- .1 ASTM C920, Specification for Elastomeric Joint Sealants.
- .2 CSA S413, Parking Structures.

1.3 **DESIGN REQUIREMENTS**

- .1 Design water repellent sealer for vehicular traffic in accordance with CSA S413.

1.4 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, limitations, preparation and installation requirements.
 - .2 Product transportation, storage, and handling requirements.
- .2 Reports/Certificates:
 - .1 Submit manufacturer's written acceptance of substrate prior to installation.
 - .2 Submit applicator's current certificate of approval, for installation of sealer, by the material manufacturer as proof of compliance.
 - .3 Submit letter certifying that materials proposed for use on this project meet criteria specified, are compatible with each other, and that the manufacturer had recommended the product for its intended end use.
 - .4 Submit inspection report after application of sealer.
 - .5 Submit certification from sealer manufacturer that installation meets specified and manufacturer's requirements.

.6 Submit a letter from the sealer manufacturer stating that the manufacturer will inspect the surface to which sealer has been applied, at the end of the first, third, and fifth years after application, and will submit a written report after each inspection to the Owner. The report shall state conditions that may adversely affect the sealer performance or cause water penetration, such as structural movement or defects, faulty construction or materials, and joint areas requiring resealing or repointing, and recommendations for corrective measures under the terms of the Warranty. This maintenance inspection shall be performed at no cost to the Owner.

.3 Closeout submittals: Submit maintenance data for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

.4 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 **QUALITY ASSURANCE**

.1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in work of similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.

.2 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.6 **DELIVERY, STORAGE, AND HANDLING**

.1 Deliver products in original factory packaging bearing identification of product, manufacturer, and batch number. Provide Material Safety Data Sheets for each product.

.2 Store product in location protected from freezing, damage, construction activity, precipitation, and direct sunlight, in strict accordance with manufacturer's recommendations.

.3 Prior to application, condition products in accordance with manufacturer's recommendations.

.4 Handle all products with appropriate precautions and care as stated on Material Safety Data Sheet.

1.7 SITE CONDITIONS

- .1 Do not install work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:
 - .1 Ambient air and surface temperature: 5°C to 38°C
 - .2 Precipitation: None.
- .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.

1.8 EXTENDED WARRANTY

- .1 Submit an extended warranty for the work of this Section in accordance with General Conditions, except that warranty period is extended to ten years from date of Contract Documents.
 - .1 Warrant against loss of water repellency when tested as follows:
 - .1 Modified ASTM C642 procedure: Treated concrete shall not absorb more than 0.75% water for a period of 24 hours.
 - .2 AASHTO T259: Concrete shall not absorb more than 250 ppm of chlorides at the 1 1/2 inch level over baseline conditions.
 - .2 Coverage: Complete repair of defective areas and reapplication of sealer.

2 Products

2.1 MATERIALS

- .1 All materials under work of this Section, including but not limited to, primers, sealants, sealers, and paints are to have low VOC content limits.
- .2 Water repellent sealer (slab-on-grade): Clear, penetrating, breathable, 100% active silane based sealer:
 - .1 'Protectosil BHN' by DRE Industries Inc.
 - .2 'MasterProtect H 1000' by Master Builders Solutions.
 - .3 'Pentreat 244-100' by W. R. Meadows.
- .3 Water repellent sealer (exterior): Clear, penetrating, water based, breathable, minimum 40% active silane based sealer:
 - .1 'Protectosil Aqua-Trete 40' by DRE Industries Inc.
 - .2 'MasterProtect H 400' by Master Builders Solutions.
- .4 Sealant: ASTM C920, Type M, Grade P, Class 25; Two-part, self-levelling type, in standard colours selected.
 - .1 MasterSeal SL-2 by Master Builders Solutions.
 - .2 Sikaflex - 2C-SL by Sika Canada Inc.
 - .3 THC 900 with epoxy primer by Tremco Ltd.
- .5 Primers: Type recommended by material manufacturers for various substrates, to promote adhesion and to prevent staining of adjacent surfaces for conditions encountered on project.

- .6 Joint backing: Round, solid section, skinned surface, soft polyethylene foam gasket stock, compatible with primer and sealant materials, 30 to 50% oversized, Shore A hardness of 20, tensile strength 140 to 200 kPa. Bond breaker type surface.
- .7 Bond breaker: Type recommended by material manufacturers to prevent bonding of sealant to back of recess.
- .8 Cleaning agents: As recommended by material manufacturer, harmless to substrates and adjacent finished surfaces.

3 Execution

3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.

3.2 PREPARATION

- .1 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.
- .2 Thoroughly clean all surfaces to receive sealer by steel shotblasting or other method approved by the manufacturer.
- .3 Rout or sawcut all cracks exceeding 1.5 mm in width and fill with sealant.

3.3 SEALER APPLICATION

- .1 Apply sealer in accordance with manufacturer's written instructions.
- .2 Apply sealer without dilution or alteration in any way.
- .3 Apply sealer with low pressure airless spray equipment (15 Psi) capable of flooding the surface to obtain uniform coverage and extending sealer 100 mm up walls.
- .4 Apply sealer at a minimum application rate of 4.3 m²/L.
- .5 Apply sealer by method other than spray application only at locations where overspray would affect adjacent materials.

3.4 SEALANT APPLICATION

- .1 Do not fill joints sooner than 30 days after concrete pours. Execute joint sealing during cool, dry ambient conditions when slab is in contracted state to minimize future joint separation.
- .2 Comply with sealant manufacturer's primer, application and temperature requirements.
- .3 Prior to sealant application, thoroughly dress and clean joints. Slightly abrade joints exposed to wheel traffic. Prime joint surfaces as required.
- .4 Mask floor to edge of joints and fill joint with sealant. After initial set, prime sealant surface and refill joints with sealant as required to produce slightly convex joint surface.
- .5 Apply sealant in tooled or sawn joints and at other locations indicated on drawings.

3.5 FIELD QUALITY CONTROL

- .1 Immediately after sealing has been completed, have the sealer manufacturer's representative visit the site to inspect, test, and approve the application. Submit written inspection report to Consultant.
- .2 Deficiencies in the application shall be repaired at no cost to Owner.

3.6 PROTECTION

- .1 Prevent traffic over sealed areas, and protect work of this Section from precipitation, freezing, and debris after installation.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for the thermal insulation work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- .2 ASTM C665, Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- .3 CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
- .4 CAN/ULC-S702, Mineral Fibre Thermal Insulation for Buildings.

1.3 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating characteristics, performance criteria, and limitations. Indicate installation requirements and techniques, storage, and handling criteria and installation procedure acceptable to manufacturer.
- .2 Certification: Submit installer's certification verifying compliance with specification requirements.

1.4 **QUALITY ASSURANCE**

- .1 Qualifications: Execute work of this Section by company specializing in thermal insulation work with minimum of three years, recent, documented experience, on work of comparable complexity and scope.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, adhesives are to have low VOC content limits.
- 2. Batt insulation:
 - .1 Fiberglass Batt insulation (non-rated): CAN/ULC-S702, Type 1, friction fit; 'Unfaced Thermal and Sound Control Batts' by Johns Manville, 'EcoTouch Pink Fiberglas Insulation' by Owens Corning Canada or 'ComfortBatt' by Rockwool.

- .2 Mineral Wool Batt insulation (fire-rated/acoustic): ASTM C665, Paperless, semi-rigid, spun stone wool fibre mats, of thickness as indicated on Contract Drawings, 'MinWool SAFB' by Johns Manville, 'SAFB Thermafiber' by Owens Corning Inc. or 'Rockwool AFB' by Rockwool.
- .3 Rigid insulation: CAN/ULC-S701, Type 4; Minimum RSI of 0.87, Extruded polystyrene, ship-lapped edges. Thickness: As indicated on Drawings.
 - .1 Styrofoam SM by Dow Chemical Canada Inc.
 - .2 Foamular C-300 by Owens Corning Canada Inc.
- 4. Cavity wall insulation (masonry cavity walls): CAN/ULC -S701, Type 3, Extruded polystyrene, ship-lapped edges. Thickness: As indicated on Drawings.
 - .1 Cavitymate by Dupont de Nemours Inc.
 - .2 Foamular C-200 by Owens Corning Canada Inc.
- 5. Cavity wall insulation (steel stud cavity walls): CAN/ULC -S701, Type 3, Extruded polystyrene, ship-lapped edges. Thickness: As indicated on Drawings.
 - .1 Cladmate by Dow Chemical Canada Inc.
 - .2 Foamular C-200 by Owens Corning Canada Inc.
- 6. Semi- mineral wool insulation: Semi-rigid stone wool conforming to CAN/ULC-S702, Type 1, minimum density 70 kg/m³, thickness as indicated. 'CavityRock' by Rockwool.
- .7 Semi-rigid mineral wool insulation: Refer to Section 07 42 41.
- .8 Spray foam insulation: In accordance with Section 07 21 19.
- .9 Adhesive for polystyrene insulation: As recommended by insulation manufacturer and approved by air/vapour barrier manufacturer when adhesive is in direct contact with air/vapour barrier membrane.

3 Execution

3.1 EXAMINATION

- .1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Ensure substrate surfaces are dry, clean, suitable to receive adhesive and free from other deleterious substances.

3.2 INSTALLATION

- .1 Install thermal insulation in longest panel sizes possible in accordance with manufacturer's instructions.

- .2 Butt insulation with moderate contact and, cut and fit them tightly around other construction elements. Offset single layer vertical joints and both vertical and horizontal joints in multiple layer applications.,
- .3 Make thermal insulation continuous, maintain thermal protection continuity and secure to prevent displacement. Ensure that insulation is tight to substrate without air gaps.
- .4 Cut and fit thermal insulation tightly around electrical boxes, plumbing and heating pipes and ducts, exterior doors and windows, and other protrusions.
- .5 Leave 75 mm separation between thermal insulation and heat emitting devices such as recessed light fixtures.
- .6 Cut and trim thermal insulation neatly to fit spaces; do not compress insulation to fit. Install only thermal insulation boards which are free from chipped or broken edges.
- .7 Fill miscellaneous cavities with insulation to maintain continuity of thermal barrier. Do not compress insulation to fit.
- .8 Arrange for Consultant to review thermal insulation before it is enclosed.

3.3 **SECUREMENT**

- .1 Batt insulation (non-rated, fire-rated/acoustic):
 - .1 Install batt insulation in partitions, between studs, and as indicated on Contract Drawings and in accordance with the manufacturer's instructions.
 - .2 Fill stud cavities to full height of partitions and carefully cut and fit required batt insulation type around services and protrusions.
- .2 Cavity wall insulation:
 - .1 Provide insulation tight to the inner wythe starting at the base of the wall in parallel courses with tight butt joints. Stagger end joints in adjacent course.
 - .2 Provide finish work level, plumb and true.
 - .3 Provide securement for cavity wall insulation with wedge type retainers in accordance with manufacturer's written instructions.
- .3 Rigid insulation (Adhesive attachment):
 - .1 Apply adhesive to thermal insulation foam boards in accordance with manufacturer's recommendations.
 - .2 Omit adhesive bonding of foam board insulation over expansion and control joints.
- .4 Spray foam insulation: In accordance with Section 07 21 19.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for sprayed foam insulation work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .2 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, Application.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Elevations, sections, materials, details of joint conditions, including door, window, entrance framing, flashings, and roof parapet connection.
- .3 Samples: Submit following samples in accordance with Section 01 33 00:
 - .1 Two 150 x 150 x 75 mm thick samples of sprayed insulation
 - .2 Two 300 x 300 mm samples of transition strips.
- .4 Certificates: Submit the following certificates in accordance with Section 01 33 00:
 - .1 Applicator's current certificate of approval by CUFCA/NECA or BASF Canada's training program.
 - .2 Applicator's current certificate of approval from material manufacturer.

1.4 **QUALITY ASSURANCE**

- .1 Perform work of this Section by a company that has a minimum of five years proven experience in installations of similar size and nature.

- .2 Contractor to be a certified member of the Canadian Urethane Foam Contractors Association/ National Energy Conservation Association (CUFCA/NECA) or be licensed under the BASF Canada Quality and Training Program "Raising Performance to New Heights" and in accordance with CAN/ULC S705.2 installation standard.
- .3 Provide quality assurance testing in accordance with CAN/ULC S705.2. Record daily results in a log book for Consultant's review.
- .4 Provide adhesion tests on transition membranes, in accordance with manufacturer's written instructions, at the perimeters of all openings. If the project comprises more than 10 openings, adhesion tests should be conducted on 15% of them. For jobs comprising 10 or fewer openings, 30% of these should undergo adhesion tests. Adhesion tests should be performed on the transition membranes at every tenth column or beam.
- .5 Mock-up:
 - .1 Construct mock-up of 3 m² minimum, of spray-in-place foam insulation to thickness as indicated on drawings, including one inside corner and one outside corner.
 - .2 Arrange for Consultant's review and acceptance, allow 24 hours before proceeding with work.
 - .3 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

1.5 **SITE CONDITIONS**

- .1 Do not install work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:
 - .1 Ambient air and surface temperature: 5°C to 40°C.
 - .2 Relative Humidity: Above 85%.
- .2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 48 hours before, during, and 48 hours after installation.

2 **Products**

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Sprayed foam insulation: CAN/ULC S705.1, closed cell, medium density, polyurethane based, and utilizing an HFO blowing agent; 'Walltite CM01' by BASF, 'Sealtite One' by Carlisle, or 'Heatlok Soya HFO' by Huntsman Building Solutions.

- .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. 'Blueskin SA' by Henry Company Canada, 'Soprasedal Stick 1100' by Soprema, 'Exo-Air 110' by Tremco, or 'Air-Shield' by W. R. Meadows.
 - .2 Primer: 'Aquatac' by Henry Company Canada Inc., 'Elastocol Stick H20' by Soprema, 'ExoAir WB Primer' by Tremco, or 'Mel-Prime Water Base' by W.R. Meadows.
 - .3 Mastic: 'Polybitume 570-05' by Henry Company Canada Inc., '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.
- 3 Execution
- 3.1 **EXAMINATION**
- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- 3.2 **PREPARATION**
- .1 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.
 - .2 Provide ventilation in area to receive sprayed foam insulation, introducing and exhausting fresh air continuously during and for 24 hours after application.
 - .3 Provide temporary enclosures to prevent spray from contaminating air beyond application area, and damage from overspray and dusting on adjacent surfaces.
 - .4 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.

- .5 If required, apply primer to substrate surfaces in accordance with manufacturer's written instructions.

3.3 **TRANSITION STRIPS**

- .1 Install transition strips at all openings, penetrations, joints, cracks, dissimilar materials, 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 oc along edges of panels and 450 mm oc 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 and conforming to CAN/ULC S705.2.
- .2 Apply sprayed foam insulation to thickness indicated on drawings and to provide continuous air retarder in locations indicated on the Drawings. Apply insulation to within 3 mm of thickness indicated on drawings. Provide one measuring pin for every 50 m².
- .3 Apply insulation in maximum 50 mm pass thickness, with a minimum wait time between passes as recommended by manufacturer.
- .4 Insulation to be continuous, level, plumb and uniform thickness throughout. Insulation shall be free of voids and imbedded foreign materials.

3.6 **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

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for air/vapour barriers Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM E1643, Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- .2 ASTM E1745, Standard Specification for Water Vapour Retarders used in contact with Soil or Granular Fill under Concrete Slabs.
- .3 CAN/CGSB 19.21-M, Sealing and Bedding Compound, Acoustical.
- .4 CAN/CGSB-51.34-M, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Samples: Submit following samples in accordance with Section 01 33 00:
 - .1 Two 300 x 300 mm samples of air/vapour barriers.
 - .2 Two samples, 300 mm long, of fastening bar.
 - .3 Duplicate samples of pipe and conduit boot.

1.4 **QUALITY ASSURANCE**

- .1 Mock-up:
 - .1 Construct one 10 m² mock-up of each type air/vapour barrier in location acceptable to Consultant indicating as a minimum one lap joint, one inside corner, one window interface, one wall electrical box, and floor pipe penetration.
 - .2 Arrange for Consultant's review and acceptance.
 - .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

1.5 SITE CONDITIONS

- .1 Do not install the Work of this Section outside of environmental ranges as recommended by manufacturer without Consultant's and Product manufacturer's written acceptance.
- .2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements before, during, and after installation.

2 Products

2.1 WALL AIR/VAPOUR BARRIER MATERIALS

- .1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Membrane air/vapour barrier: 1.0 mm thick, single-ply, self adhering, self sealing, rubberised asphalt, bonded to a cross-laminated high density polyethylene film.
 - .1 'CCW 705' by Carlisle Coatings & Waterproofing.
 - .2 'Blueskin SA' by Henry Company Canada Inc.
 - .3 'Sopraseal Stick 1100 T' by Soprema.
 - .4 'Exo-Air 110' by Tremco.
 - .5 'Air-Shield' by W. R. Meadows.
- .3 Primer:
 - .1 'Cav-Grip Primer' by Carlisle Coatings & Waterproofing.
 - .2 'Blueskin Adhesive' by Henry Company Canada Inc.
 - .3 'Elastocol Stick' by Soprema.
 - .4 'ExoAir Primer' by Tremco
 - .5 'Mel-Prime' by W.R. Meadows.
- .4 Mastic:
 - .1 'CCW 704 Mastic' by Carlisle Coatings & Waterproofing.
 - .2 'Polybitume 570-05' by Henry Company Canada Inc.
 - .3 'Sopramastic' by Soprema.
 - .4 'Acoustical Sealant' by Tremco
 - .5 'Sealtight Pointing Mastic' by W.R. Meadows.
- .5 Fastening bar: Continuous 25 mm wide x 3 mm thick aluminum bar, predrilled for mechanical attachment.
- .6 Fasteners: As specified herein or manufacturer's recommended fastener for attaching to Substrate.

2.2 UNDER SLAB VAPOUR RETARDER MATERIALS

- .1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 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.

2.3 SHEET VAPOUR RETARDER MATERIALS

- .1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Sheet vapour retarder: 'Super Six' Polyethylene film to CAN/CGSB-51.34, 0.15 mm (6 mil) thick.
 - .1 Joint sealing tape: Air and vapour resistant pressure sensitive adhesive tape, type recommended by sheet vapour retarder manufacturer, 50 mm wide for lap joints and perimeter seals, 25 mm wide elsewhere.
 - .2 Sealant: CAN/CGSB 19.21; One-part, non-sag, non-bleeding, non-drying, non-hardening, sealant shall remain tacky for permanent bonding to all surfaces; 'Tremco Acoustical Sealant' by Tremco Ltd. or approved alternative.

3 Execution

3.1 EXAMINATION AND COORDINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.
- .2 Verify that existing substrates to receive air/vapour barrier are clean, dry, sound, smooth, and continuous.
- .3 Coordinate installation of air/vapour barriers with work of other Sections to achieve a air/vapour tight building envelope.

3.2 MEMBRANE WALL AIR/VAPOUR BARRIER INSTALLATION

- .1 Fill substrate voids, gaps, depressions, cracks, and joints with mastic until continuous, smooth, substrate for air/vapour barrier is achieved.

- .2 Prime substrate surfaces to receive air/vapour barrier in accordance with manufacturer's instructions, at recommended application rate, allow to dry. Vary coverage to suit surface porosity.
- .3 Prime surfaces. Re-prime surfaces if not covered with air/vapour barrier within 4 hours.
- .4 Install mastic where required to ensure integrity of air/vapour barrier installation at protrusions and other complex details.
- .5 Install air/vapour barrier in accordance with manufacturer's instructions in locations indicated.
- .6 Lap air/vapour barrier ends and edges 50 mm minimum. Roll air/vapour barrier and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.
- .7 Extend air/vapour barrier as required to connect to other components of Work comprising air/vapour barrier system.
- .8 Cut and fit air/vapour barrier as required for passage of protrusions, ensuring continuous adherence to substrate.
- .9 At end of days' Work, trowel mastic water cut-off along uppermost edge of incomplete air/vapour barrier assembly, to prevent loss of adhesion and damage air/vapour barrier.
- .10 Supply and install continuous mechanical fastening bar to clamp air/vapour barrier both sides of unfilled gaps, cracks, and joints.

3.3 **UNDER SLAB VAPOUR RETARDER INSTALLATION**

- .1 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.
- .2 Lap vapour barrier over footings and seal to foundation walls.
- .3 Overlap joints 150 mm and seal with manufacturer approved sealing tape.
- .4 Seal all penetrations (including conduits and pipes) with manufacturer's pipe boot.
- .5 Use sheets of largest practical size to minimize joints.
- .6 Inspect for continuity. Repair punctures and tears with sealing tape before work is concealed.
- .7 Ensure continuity of vapour retarder is maintained at junctures with other materials.

3.4 SHEET VAPOUR RETARDER INSTALLATION

- .1 Ensure services are installed and inspected prior to installation of retarder.
- .2 Install sheet vapour retarder on the warm side of exterior wall, roof, and ceiling assemblies, prior to installation of roof insulation or interior finishes to form a continuous vapour retarder.
- .3 Use sheets of largest practical size to minimize joints.
- .4 Inspect for continuity. Repair punctures and tears with sealing tape before work is concealed.
- .5 At exterior surface openings, cut vapour retarder to form openings and ensure material is lapped and sealed to frame.
- .6 Ensure continuity of vapour retarder is maintained at junctures with other materials.
- .7 At perimeter seals, seal perimeter of sheet vapour retarder as follows:
 - .1 Apply continuous bead of sealant to substrate at perimeter of sheets.
 - .2 Lap sheet over sealant and press into sealant bead.
 - .3 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.
- .8 Seal lap joints of sheet vapour retarder as follows:
 - .1 Attach first sheet to substrate.
 - .2 Apply continuous bead of sealant over solid backing at joint.
 - .3 Lap adjoining sheet minimum 150 mm and press into sealant bead.
 - .4 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.
- .9 Seal electrical switch and outlet device boxes that penetrate vapour retarder as follows:
 - .1 Wrap boxes with film sheet providing minimum 300 mm perimeter lap flange.
 - .2 Apply sealant to seal edges of flange to main vapour retarder and seal wiring penetrations through box cover.

3.5 FIELD QUALITY CONTROL

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

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

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

1.2 **REFERENCES**

- .1 ASTM C920, Specification for Elastomeric Joint Sealants.
- .2 ASTM C1193, Standard Guide for Use of Joint Sealants.
- .3 ASTM E96, Standard Test Methods for Water Vapor Transmission of Materials.
- .4 ASTM E2178, Standard Test Method for Air Permeance of Building Materials.

1.3 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating installation details, physical properties and detailed application and installation instructions.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Adjacent construction and typical details, dimensions, thickness, method of application, protection and penetration details.
 - .2 Location of each membrane penetration.
 - .2 Shop drawings to coordinate and show transitions with adjacent assemblies and system to ensure a continuous air barrier system.

1.4 **QUALITY ASSURANCE**

- .1 Installer's qualifications: Perform Work of this Section by company, approved by Product manufacturer and having 5 years recent experience in Work of comparable complexity and scope.
- .2 Mock-up:
 - .1 Construct one 3 m² mock-up of air barrier in location acceptable to Consultant indicating as a minimum one lap joint, one inside corner, one window interface, and one penetration.
 - .2 Arrange for Consultant's review and acceptance.
 - .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
- .3 Pre-Installation Meeting: Arrange meeting on Site to be attended by Consultant, Contractor, and air barrier manufacturer's representative to review installation procedures, interfaces with adjacent work, conditions under which work will be performed, inspect the surfaces to receive the air barrier, and installation procedures 48 hours in advance of installation.

1.5 **DELIVERY, STORAGE AND HANDLING**

1. Protect materials from direct exposure to sunlight and physical damage.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers and sealants are to compatible and have low VOC content limits.
- .2 Vapour permeable air barrier: 23 mils thick, minimum water vapour permeance of 19 perms when applied to glass mat sheathing in accordance with ASTM E96, maximum air permeance 0.02 L/s m² in accordance with ASTM E2178, single-ply self adhering membrane consisting of engineered film and permeable adhesive with poly-release film; 'Blueskin VP160' by Henry Company Canada Inc. 'AirOutshield SA 280' by SRP Canada Inc., or 'Air-Shield SMP' by W. R. Meadows.
- .3 Primer: Low VOC quick setting rubber based adhesive 'Blueskin LVC Adhesive' by Henry Company Canada Inc. or approved primer by W. R. Meadows.
- .4 Sealant: ASTM C920, Type S, Grade NS, Class 25; Moisture sure, medium modulus polymer modified sealing compound 'HE925 BES' by Henry Company Canada Inc. or approved alternative by Dörken Systems Inc. or VaproShield for their respective membranes.

3 Execution

3.1 **EXAMINATION**

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

3.2 **APPLICATION**

- .1 Ensure surfaces to receive membrane are sound, dry, clean, and free from oil, grease, dirt, excess mortar or other contaminates.
- .2 Fill substrate voids, gaps, depressions, cracks, and joints with mastic or other approved fill material until continuous, smooth, substrate for air barrier is achieved.
- .3 Prime substrate surfaces to receive air barrier in accordance with manufacturer's instructions, at recommended application rate, allow to dry. Vary coverage to suit surface porosity.
- .4 Prime surfaces. Re-prime surfaces if not covered with air barrier within 4 hours.

- .5 Install mastic and sealant where required to ensure integrity of air barrier installation at protrusions and other complex details. Install sealant in accordance with ASTM C1193.
- .6 Install air barrier in accordance with reviewed shop drawings and manufacturer's instructions in locations indicated.
- .7 Lap air barrier ends and edges 50 mm minimum. Roll air barrier and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.
- .8 Extend air barrier as required to connect to other components of work comprising air barrier system.
- .9 Provide end-dams and terminations fabricated from same material as air barrier or material recommended by membrane manufacturer at sills, lintels, openings, and where horizontal surfaces intersect with vertical surfaces to ensure moisture is shed to exterior.
- .10 Cut and fit air barrier as required for passage of protrusions, ensuring continuous adherence to substrate.
- .11 Seal around masonry reinforcing or ties and all penetrations.
- .12 At end of days' work, seal water cut-off along uppermost edge of incomplete air barrier assembly to prevent loss of adhesion and damage air barrier.
- .13 Do not expose air barrier to sunlight for more than 30 days prior to enclosure.

3.3 **FIELD QUALITY CONTROL**

- .1 Do not cover or permit to be covered any portion of the membranes until they have been inspected by the Consultant or by an inspection agency appointed by the Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, tools, equipment and services necessary for exterior soffit system work complete in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .2 ASTM C920, Specification for Elastomeric Joint Sealants.
- .3 CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles.

1.3 **DESIGN REQUIREMENTS**

- .1 Design structural steel studs to form soffit system details and connections, where not shown on Drawings.
- .2 Design soffit system to accommodate expansion and contraction of soffit elements without causing buckling, failure of joints, undue stress on fasteners or other effects detrimental to appearance or performance.

1.4 **SUBMITTALS**

- .1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
- .1 Performance criteria, compliance with appropriate reference standard, characteristics, and system limitations.
- .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
- .1 Details, sections, dimensions, tolerances, connections, terminations, control joints, system components, installation sequence, accessories and other pertinent information required for proper and complete installation.
- .2 Complete design data to confirm that soffit system meet design requirements specified.
- .3 Samples: Submit two 300 x 300 mm samples of complete soffit system in accordance with Section 01 33 00.
- .4 Reports: Submit written inspection reports within 5 working days after each inspection.

- .5 Closeout submittals: Submit maintenance and cleaning instructions for soffit system for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.
- .6 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 QUALITY ASSURANCE

- .1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience installing work of similar size and nature and that is approved by system manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Soffit system manufacturer shall conduct Site inspections, prepare and submit written inspection reports verifying that this part of Work is in accordance with Contract Documents and reviewed shop drawings. Perform inspections once per week minimum.
- .3 Mock-up:
 - .1 Construct one 3000 mm minimum mock-up of soffit system in location acceptable to Consultant.
 - .2 Arrange for Consultant's review and acceptance.
 - .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

1.6 SITE CONDITIONS

- .1 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 35⁰C
 - .2 Precipitation: None.
- .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.
- .3 Do not proceed with application of materials immediately prior to, during or immediately after inclement conditions, or if wet weather is anticipated within 24 hours after application. Do not apply materials to wet, frozen, or frosted surfaces.
- .4 Protect applied coatings from rapid evaporation during dry and hot weather.

1.7 **EXTENDED WARRANTY**

- .1 Submit an extended warranty for soffit system work in accordance with the General Conditions, except that the warranty period is extended to 5 years from date of Contract Documents.
 - .1 Warrant against failure to meet the design criteria and requirements such as failure to stay in place, cracking, warping, and finish degradation.
 - .2 Coverage: Complete replacement including affected adjacent Work.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, coatings, sealants, primers, and sealers are to have low VOC content limits.
- .2 Aluminum Panels (wood-look): 1.78 mm aluminum alloy panels, pre-finished wood-look panels. Finish exposed surfaces of aluminum components as PPG Duranar XL Plus, 3 coat, coil coated fluoropolymer thermal setting enamel containing Kynar 500 resin, meeting requirements of AAMA 605, minimum thickness 2.4 mil, colour: to be determined. Concealed aluminum finish: Mill finish.
- .3 Wood panels: Cedar wood soffit system. Manufacturer to be selected by the Consultant.
- .4 Accessories: Hot-dip galvanized in accordance with CAN/CSA-G164-M, in locations shown on Contract Drawings.
- .5 Fasteners: Provide type 304 stainless steel fasteners.
- .6 Soffit vents: 115 mm wide continuous, high impact, rigid, same material of each type soffit vent with continuous insect screen. As recommended by soffit manufacture.
- .7 Sealant and sealant primer: In accordance with Section 07 92 00.

2.2 **MIXES**

- .1 Measure and batch materials by either volume or weight only, to accurately control and maintain proportions. Mix and prepare materials in accordance with manufacturer's written instructions.
- .2 Do not add any additional additives, rapid binders, antifreeze, accelerators, fillers or pigments without the written approval of the manufacturer and Consultant.

3 Execution

3.1 **EXAMINATION**

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

3.2 **PREPARATION**

- .1 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, and other foreign matter detrimental to performance. Ensure environmental and site conditions are suitable for installation of system.
- .2 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.
- .3 Prepare surfaces in accordance with manufacturer's written instructions.
- .4 Protect finished work at end of each day or on completion of each section of work from water penetration. Protect completed installation from moisture for 48 hours minimum.

3.3 **SOFFIT SYSTEM**

- .1 Install soffit system in accordance with reviewed shop drawings and manufacturer's written instructions. Comply with system manufacturer's requirements regarding terminations at end of each days work and resumption of work.
- .2 Install panels in accordance with reviewed shop drawings and manufacturer's written instructions. Comply with system manufacturer's requirements regarding terminations at end of each days work and resumption of work.
- .3 Install continuous soffit vents in soffits as indicated on drawings to provide ventilation of concealed soffit spaces in accordance with OBC requirements.

3.4 **CONTROL JOINTS**

- .1 Install 12.7 mm control joints at the following locations:
 - .1 Soffit abuts a structural element, dissimilar wall or other vertical penetration.
 - .2 Construction changes within the plane of the soffit.
 - .3 Ceiling or soffit dimensions exceed 15 m in either direction.
 - .4 Locations indicated on drawings.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for aluminum panel siding, soffit and screen work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 AAMA 2605, High Performance Organic Coatings on Architectural Extrusions and Panels.
- .2 AAMA CW-10, Care and Handling of Architectural Aluminum from Shop to Site.
- .3 ANSI B18.6.4, Screws, Tapping and Metallic Drive, Inch Series, Thread Forming and Cutting.
- .4 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- .5 ASTM C920, Specification for Elastomeric Joint Sealants.
- .6 CAN/CSA-G40.20/G40.21M, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels.
- .7 CSA S136, Cold Formed Steel Structural Members.

1.3 **DESIGN REQUIREMENTS**

- .1 Design aluminum panel system as a “dry joint system” and to withstand live, dead, lateral, wind, seismic, handling, transportation, and erection loads, imposed and other loads.
- 2. Prevent rain penetration through system. Design system based on “Rain Screen Principle” in accordance with the National Research Council. Volume to vent ratio should not exceed 25 m. Panels should be compartmentalized at joints. Incorporate means of draining to the exterior.
- .3 Design aluminum panel system to accommodate thermal movements of the components and structural movements to provide an installation free of oil canning, buckling, delamination, failure of joint seals, excessive stress on fasteners or any other detrimental effects.
- .4 Design aluminum panel system to prevent rattling and vibration of panels, oversteering of fasteners and clips, and other detrimental effects on the system.
- .5 Panel removal: System design to allow removal of individual panels within system.
- .6 Design miscellaneous, additional structural framing members as required to complete aluminum panel system, where not indicated on Contract Drawings.

- .7 The attachment face of subgirts supporting the panel system must not deflect vertically more than 3 mm due to the dead load of the panel system.

1.4 SUBMITTALS

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Elevations, details, profiles, dimensions, thickness of materials, finishes, methods of joining, joint location, special joints, methods of anchoring, anchor and thermal clip details, types of sealants and gaskets, waterproof connections to adjoining work, details of other pertinent components of the work, and compliance with design criteria and requirements of related work.
 - .3 Samples:
 - .1 Submit samples in accordance with Section 01 33 00:
 - .1 600 x 600 mm samples of panel system showing fully assembled components including face sheets, sub-girts, insulation, liner panel, thermal clip and concealed sealant. Sample to be fabricated using exact colour and gauges specified.
 - .2 300 x 300 mm face sheet samples for soffits and screens.
 - .4 Closeout Submittals: Provide maintenance instructions for incorporation into Operation and Maintenance Manual, specified in Section 01 78 00.

1.5 QUALITY ASSURANCE

- .1 Retain a licensed Professional Engineer, registered in the Province of Ontario, to perform following services for prefinished panel work:
 - .1 Design of aluminum panel system.
 - .2 Design of anchors, supports and accessories to meet seismic requirements.
 - .3 Review, stamp, and sign shop drawings.
 - .4 Conduct shop and field inspections and prepare and submit inspection reports.
- .2 Perform work of this Section only by a Subcontractor of recognized standing who has adequate plant, equipment, and skilled workers to perform it expeditiously, and is known to have been responsible for satisfactory installations similar to that specified during a period of at least the immediate past ten years.

- .3 Execute steel welding to CSA W59-M by fabricators certified by the Canadian Welding Bureau to CSA W47.1.
- .4 Execute aluminum welding by fabricators certified by the Canadian Welding Bureau to CSA W47.2-M.
- .5 Execute finishing coatings and metal pre-treatments by applicators approved in writing by the manufacturer of the coatings and under the supervision of the manufacturer's qualified representative.
- .6 Mock-up:
 - .1 Fabricate, deliver, and erect a 3 m² mm high mock-up panel of aluminum panel system in location acceptable to Consultant.
 - .2 Demonstrate full panel fabrication and installation techniques, confirm stiffness/absence of deformation, finish, anchoring devices, air barrier sealing, joint detailing and sealing, and quality of workmanship.
 - .3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.
- .7 Pre-Installation Meeting: Arrange meeting on Site to be attended by Consultant, Contractor, and panel manufacturer's representative to review installation procedures, interfaces with adjacent work, conditions under which work will be performed, inspect the surfaces to receive the vapour retarder, and installation procedures 48 hours in advance of installation.

1.6 **DELIVERY, STORAGE, AND HANDLING**

- .1 Handle aluminum work in accordance with AAMA CW-10. Protect aluminum surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Do not remove before final cleaning of building.
- .2 Remove and replace all damaged and unsatisfactory materials which are deemed unsuitable for use at this Section's own expense.

1.7 **EXTENDED WARRANTY**

- .1 Submit an extended warranty for aluminum panel work in accordance with General Conditions, except that warranty period is extended to 3 years from date of Contract Documents.
 - .1 Warrant against leaking, warping, twisting, joint, and finish failure.
 - .2 Coverage: Complete replacement including affected adjacent parts.
- .2 Manufacturer's Warranty: Provide panel manufacturer's written warranty naming Owner as beneficiary and covering failure of factory-applied exterior finish on prefinished metal panels within the warranty period; warrant finish per ASTM D4214 for chalk not in excess of 8 NBS units and fade not in excess of 5 NBS units. Warranty period for finish: 10 years from date Work is certified as substantially performed.

2 Products

2.1 **ACCEPTABLE PANEL MANUFACTURER(S)**

- .1 Aluminum Wall Panels: 3 mm aluminum alloy panels, pre-finished, using proprietary aluminum extrusions; 'Aluminum 125" Wall Panels' by Kanalco Ltd., 'Sovereign' by VicWest or approved alternative by Flynn or Ontario Penalization.

2.2 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, sealants, paints, and coatings are to have low VOC content limits.
- .2 Sheet aluminum: Aluminum Association 6061-T6 to ASTM B209.
- .3 Finish:
 - .1 Exposed to view: PPG Duranar XL Plus, 3 coat, coil coated fluoropolymer thermal setting enamel containing Kynar 500 resin, meeting requirements of AAMA 2605, minimum thickness 2.4 mil. Colour: Refer to Material Legend as indicated on Drawings. Concealed aluminum finish:
 - .2 Mill finish.
- .4 Structural shapes, plates, sag rods, and similar items: CAN/CSA-G40.20-G40.21-M, Grade 350W.
- .5 Air/Vapour barrier: In accordance with Section 07 26 00.
- .6 Z-girts and C channels: CAN/CSA S136-M; Minimum 1.2 mm thick, Z275 galvanized. Depth as indicated on Contract Drawings. Z-girts to be thermally broken at mid-point of insulation thickness.
- .7 Thermal spacer: 100% pultruded glass fibre and thermoset polyester resin thermal spacer complete with fastener in depth indicated on Contract Drawings; Cascadia Clip by Interra Architectural Products or approved alternative.
- .8 Provide all additional structural supports not shown on Drawings as required.
- .9 Fasteners: Concealed, ANSI B18.6.4, stainless steel Type 304.
- .10 Flashings, Closure Pieces, Trim: Same material and colour as panels.
- .11 Insulation: CAN/ULC-S702, Type 1, minimum 70 kg/m³, Semi-rigid mineral wool. Thickness as indicated.
 - .1 'Thermafiber RainBarrier 45' by Owens-Corning.
 - .2 'CavityRock' by Roxul Inc.
 - .3 Insulation fasteners: Stik-Clip with retaining washer.
- .12 Clips and Panel Reinforcement: Extruded aluminum.

- .13 Sealant: ASTM C920, Type S, Grade NS, Class 100/50; One-part, low-modulus, moisture-curing, silicone. 'Dow Corning 790' by Dow Corning or 'Spectrem 1' by Tremco. Colour as selected by Consultant. Primer as recommended by manufacturer.
- .14 Joint backing: Product as recommended by siding sealant manufacturer.
- .15 Touch-up paint: as recommended by panel manufacturer.
- .16 Isolation coating: Bituminous coating, acid and alkali resistant material.

2.3 **FABRICATION**

- .1 Fabricate facings and concealed support members in a manner which will provide an installation free of exposed fastenings, with sufficient support and allowance for thermal movement to prevent facing distortion. Take site measurements before proceeding with production.
- .2 Fabricate components of the system at factory, ready for field installation. Include full continuous joint reveals within system.
- 3. Fabricate facings flat, true, free of marks, without visible distortion and with edges straight and true. Make all planes true, and corners square and bend of minimum radius.
- .4 Provide proprietary aluminum extrusions to manufacturer's standard profiles for a complete installation. Extrusions shall be full length around panel perimeter for panel reinforcement and alignment. Intermittent clips are unacceptable.
- .5 Changes of plans, parallel or transverse to longitudinal axis shall be accomplished as detailed on shop drawings in the factory wherever practical and with a minimum of field fabrication.
- .6 Form panels to dimensions indicated with tolerances to accommodate expansion and contraction between panels and structure members. Accurately form shaped panels.
- .7 Fabricate panels with flanges on all sides.
- .8 Factory fabricate accessory and trim components ready for installation.
- .9 Polish smooth all exposed edges, corners and ends, free from sharp edges.
- .10 Maximum allowable tolerances shall be as follows:
 - .1 Panel bow: In a concave or convex direction to be 0.5% of panel dimension width and length.
 - .2 Panel flatness: Rises and falls across the panel, (local bumps and depressions) will not be accepted.
 - .3 Panel tolerance:
 - .1 Width: 2 mm.
 - .2 Length: 4 mm.

- .3 Thickness: 0.2 mm.
- .4 Squareness: 5 mm maximum.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify that backup construction is aligned for proper installation of panels before commencing erection.
- .3 Protect metal surfaces in contact with concrete, masonry mortar, plaster or other cementitious surface and aluminum to steel surfaces with isolation coating.

3.2 **SOFFIT AND SIDING INSTALLATION**

- .1 Supply and install miscellaneous, additional structural framing members, required to complete aluminum panel system, where not indicated on Contract Drawings.
- .2 Apply isolation coating to supporting structural framing to isolate airseal liner panel and to prevent galvanic corrosion.
- .3 Install air/vapour retarder in accordance with Section 07 26 00.
- .4 Install thermal spacer to substrate in accordance with manufacturer's written instructions.
- 5. Erect panels complete with girts, clips, and fasteners, to meet design criteria. Anchor each individual panel over solid backing. Ensure that all penetrations through air/vapour barrier are sealed.
- .6 Install panels, support and anchoring system, fasteners, trim and related items to lines and elevations indicated and in strict accordance with reviewed shop/erection drawings and manufacturer's printed instructions. Carefully co-ordinate work with other Sections.
- .7 Anchor component parts to transmit wind loading and other stresses to anchorage system.
- .8 Install insulation in continuous contact with air/vapour retarder and neatly fitted between girts, supports, and anchoring system.
 - .1 Install insulation by adhesive clip method in accordance with manufacturer's specifications.

- .2 Locate clips 100 mm from edges of panels where they abut other materials and at joints between panels otherwise, spaced throughout at 300 mm to 450 mm centres each way.
- .3 At clip locations clean supporting surfaces and apply 50 mm square film of adhesive; coat clips with adhesive and press firmly to wall, holding in place until adhesive exudes through clip base perforations; remove excess adhesive to permit curing; impale insulation panels on clips and secure.
- 9. Erect panel system in accordance with manufacturer's instructions and under direct supervision of the manufacturer.
- .10 Repair all damages and all penetrations in the installed membrane air barrier, caused by work of this Section, using the same air barrier material.
- .11 Installed panels shall not deviate from overall plane or alignment by more than 1:1000. Joints shall be hairline wherever possible or a maximum of 15 mm where indicated. Joints shall not be wavy, out of line or of different width from panel to panel.
- .12 Install all exposed work of this Section with concealed clips and fasteners. Exposed fasteners not acceptable.
- .13 Install all metal flashings within and at bottom of metal panel system.
- .14 Ensure drainage of any moisture which may occur within the system to the exterior.
- .15 Damaged panels, waviness, warp or distortion of finished work will not be accepted.
- .16 Completed installation shall be free from rattles, wind whistles, noise due to thermal movement and other noises.
- .17 Install metal materials during suitable weather conditions only.
- .18 Openings:
 - .1 Provide all openings required in preformed metal panel system.
 - .2 Provide required metal flashings around penetrations through metal panels. Ensure complete watertight seal.
- .19 Joint Backing and Sealant:
 - .1 Prepare substrate surface and mask as recommended by sealant manufacturer.
 - .2 Install joint backing and sealant at perimeter of aluminum panel system and where indicated on drawings for weathertight installation. Tool sealant to concave profile.
 - .3 Seal around all openings and all other locations indicated or required to provide weathertight and watertight seal.

3.3 **SCREEN INSTALLATION**

- .1 Install screen in accordance with reviewed shop drawings and manufacturer's written instructions.

- .2 Attach aluminum panels directly mounted to framing using approved concealed fasteners and clips.
- .3 Isolate aluminum from dissimilar metal to prevent galvanic action.

3.4 **REPAIR**

- .1 Remove damaged, dented, defaced, defectively finished, or tool marked components and replace with new, unless minor blemishes are approved by Consultant.
- .2 Only with approval of Consultant, refinish shop applied finishes in field with compatible materials to manufacturer's written instructions.

3.5 **CLEANING**

- .1 Remove all strippable protective film from the work as it is erected and prior to moving on to the next bay or grid.
- .2 Wash down exposed exterior surfaces using solution of mild non-acidic detergent in warm water, applied with soft clean wiping cloths.
- .3 As work progresses, remove excess sealant with recommended solvent and which will not affect metal, finished surfaces, or adjacent surfaces and materials.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment, and services necessary for built-up bituminous roofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM C1177/C1177M, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
- .2 ASTM D1863, Specification for Mineral Aggregate Used on Built-up Roofs.
- .3 ASTM D2178, Specification for Asphalt Glass (Felt) Used in Roofing and Waterproofing.
- .4 ASTM D3273, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
- .5 ASTM D4601, Specification for Asphalt-Coated Glass Fiber Base Sheet used in Roofing.
- .6 CSA A123.4-M, Bitumen for Use in Construction of Built-Up Roof Coverings and Dampproofing and Waterproofing Systems.
- .7 CSA A123.21, Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems.
- .8 CGSB 37-GP-9Ma, Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing.
- .9 CGSB 37-GP-15M, Application of Asphalt Primer for Asphalt Roofing, Dampproofing and Waterproofing.
- .10 CAN/CGSB 37.29-M, Rubber-Asphalt Sealing Compound.
- .11 CAN/CGSB 51.33-M, Vapour Barrier Sheet, Excluding Polyethylene, for Use in Building Construction.
- .12 CAN/ULC S102.2, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies
- .13 CAN/ULC S704, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced.
- .14 CAN/ULC S706, Standard for Fibreboard Uses.
- .15 CRCA Roofing Manual, Canadian Roofing Contractors Association.
- .16 OIRCA, Ontario Industrial Roofing Contractors Association.

1.3 SUBMITTALS

- .1 Product data:
 - .1 Submit copies of manufacturer's product data in accordance with Section 01 33 00 indicating:
 - .1 Systems, materials, and methods of installation proposed for use.
 - .2 Identify systems and component.
 - .3 Certify compliance of each component with applicable standards.
 - .4 Submit cold weather construction procedures and methods of protection which will be initiated, installed and maintained when ambient temperature falls below 0°C.
- .2 Shop Drawings: Submit Shop Drawings in accordance with Section 01 33 00 indicating roof layout, sections, details, materials, fastener layout, flashings and membrane terminations, perimeter securement, vapour barrier terminations, insulation wrapping procedures, tapered insulation layout, membrane penetrations, control joints, and roof accessories.
- .3 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00
 - .1 Roof sheathing and adhesive.
 - .2 Vapour retarder and adhesive.
 - .3 Insulation board.
 - .4 Tapered insulation.
 - .5 Insulation fastener.
 - .6 Base sheet.
 - .7 Roofing felts.
 - .8 Flashings.
 - .9 Roof accessories.
 - .10 Aggregate including gradation certification.
- .4 Reports and Certificates:
 - .1 Submit copy of membership in good standing of OIRCA.
 - .2 Submit written certification from manufacturer, stating that materials proposed for use on this project meet criteria specified and are compatible with each other.
 - .3 Submit Pre-Installation Notice (PIN): Copy to show that manufacturer's required Pre-Installation Notice (PIN) has been accepted and approved by the manufacturer.
 - .4 Submit project specific report, issued by certified material testing laboratory, confirming that proposed roofing assembly conforms to CSA A123.21. As a minimum report shall indicate uplift pressures for field of roof, perimeter of roof and corners of roof.
- .5 Close-out submittals:
 - .1 Submit close-out submittals in accordance with Section 01 78 00.
 - .2 Submit membrane manufacturer's certificate that membrane has been installed in accordance with Contract Documents.
 - .3 Submit extended warranties.

- .6 Extended warranties: Submit extended warranties signed and registered by the manufacturer providing the warranties in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 **QUALITY ASSURANCE**

- .1 Qualification: Perform work of this Section by a company that is a member in good standing of the Ontario Industrial Roofing Contractors Association (OIRCA) and has a minimum of 5 years proven acceptable roofing experience on installations of similar complexity and scope.
- .2 Ensure roofing system has been tested and conforms to CAN/CSA A123.21 to ensure wind uplift resistant applicable to the Place of Work.
- .3 Perform roofing work in accordance with CRCA Roofing Specifications Manual, and to applicable CSGB Specifications except where indicated otherwise.
- .4 Ensure membrane manufacturer's representative has full access to this work for proper inspection prior to and during membrane installation. Roof inspections shall be conducted every other production day or minimum two times per week. Membrane manufacturer to certify that roof installation was in conformance to manufacturer's written requirements.
- .5 Pre-installation meetings: Arrange meeting on Site to be attended by Consultant, Contractor, and roofing manufacturer's representative to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver Products in original containers and keep in protective storage until used.
- .2 Indicate on containers or wrappings of Products:
 - .1 Manufacturer's name and brand.
 - .2 Compliance with applicable standard.
 - .3 Mass where applicable.
- .3 Handle and store Products to prevent damage. Keep manufacturer's labels and seals intact. Store bitumen containers in upright position and roofing rolls on end to prevent flattening. Ensure that shelf life of Products has not expired.
- .4 Protect Products from inclement weather. Keep insulation and roofing felts dry. Remove from storage only as much Products as can be applied, made weathertight, and covered with roofing in same day. Do not install Products which are damp at time of installation or showing evidence of having been damp or exposed to moisture.
- .5 Store roofing felts for minimum of 24 hours in area kept at 10°C and remove for application with minimum exposure to low temperatures. Keep felts dry, stored off-the-ground, on end and well ventilated.

- .6 Do not store gravel on roof ahead of demand. Bring gravel to roof only as it is required for spreading on roof as work proceeds.
- .7 Do not store insulation or roofing felts on roof. Store them under cover while roofing work is not in progress.
- .8 Place 19 mm thick plywood runways over work to enable movement of Product and other traffic.
- .9 Where hoisting or pumping occurs adjacent to construction, hang tarpaulins to protect walls and other surfaces. Locate kettle so smoke will not discolour adjacent building surfaces.
- .10 Have a minimum 9 kg. dry chemical fire extinguisher fully charged and in operable condition at every location where open flames are used.
- .11 Use warning signs and barriers. Maintain in good order until completion of work.
- .12 Clean off drips and smears of bituminous immediately.
- .13 Dispose of rain water off roof and away from face of building until roof drains or hoppers are installed and connected.
- .14 At end of each day's work or when stoppage occurs due to inclement weather, protect completed work and Products.

1.6 **SITE CONDITIONS**

- .1 Install roofing on dry deck, free of snow and ice, use only dry Products and apply only during weather that will not introduce moisture into roofing system.
- .2 Apply roofing only when air and surface temperatures are above 4⁰C, have been so for at least 48 hours and are not likely to go below 4⁰C, until work is completed.
- .3 Proceed with work when temperatures are below 4⁰C only with mutual documented agreement between Contractor and Consultant.

1.7 **EXTENDED WARRANTY**

- .1 Manufacturer Warranty: Manufacturer full system warranty in which manufacturer agrees to repair or replace components of roofing system that fail in material or workmanship within warranty period covering all costs of material and labour.
 - .1 Work in this section includes sheet metal and termination details installed by the roof system installer and approved by the roof system manufacturer.
 - .2 Warranty Duration: 20 Years from date of completion.
- .2 Installer Warranty: Format acceptable to Manufacturer, Owner and Consultant.
 - .1 Work in this section includes sheet metal and termination details installed by the roof system installer and approved by the roof system manufacturer.
 - .2 Warranty Duration: 2 Years from date of completion.

- .3 Manufacturer Inspection and Preventive Maintenance Services:
 - .1 To report maintenance responsibilities necessary for preservation of Owners warranty rights and to perform periodic routine maintenance to maintain roof warranty at no additional cost to owner.
 - .2 Period: Years 2, 5, 10 and 15 from date of completion.

2 Products

2.1 ACCEPTABLE MANUFACTURERS

- .1 This specification is written on the basis of a three ply cold-applied built-up roofing system by Tremco Canada. Specified manufacturer's products establish the minimum acceptable standards for the work of this Section. Approved roofing systems consisting of similar roof configuration and components will be considered provided they are deemed to be consistent with the roof system indicated and components listed below. Roofing systems not comprised of similar roof configuration and components will not be acceptable.

2.2 MATERIALS

- .1 All materials under work of this Section, including but not limited to, adhesives and primers are to have low VOC content limits.
- .2 Primer: non-fibrated, asbestos free, asphalt cutback primer, to CGSB 37-GP-9Ma; 'TREMprime QD' by Tremco Canada.
- .3 Air and Vapour Barrier: ASTM D1970/D1970M, minimum of 1.0 mm (40-mil) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 3 ng/Pa x s x sq. m (0.05 perm); cold-applied, with slip-resisting surface and release paper backing. 'AVC Membrane and Primer' by Tremco Canada. Provide primer when recommended by sheet manufacturer..
- .4 Insulation:
 - .1 Base layer: CAN/ULC S704, Type 3, Class 2, rigid, closed cell, polyisocyanurate foam insulation integrally laminated to perforated black glass reinforced felt facers, square edges, thickness as indicated on Contract Drawings, use maximum size board possible. Insulation thickness under 50 mm use single layer board. Insulation thickness over 50 mm use two equal thickness boards. 'Trisotech Roof Insulation' by Tremco Canada.
 - .2 Tapered insulation: Factory pre-engineered tapered fibreboard insulation in thickness sufficient for slopes shown on Contract Drawing; manufactured by Accu-Plane Systems Inc., Firestone or Posi-Slope Manufacturing Ltd.
 - .3 Cover board insulation: High strength polyiso coverboard with glass facers, 12 mm thick 'Acfoam-HS Coverboard' by Atlas Roofing Company or approved alternative.
- .5 Roofing Membrane: 1.4 mm thick polyester-glass-polyester tri-laminate reinforced asphalt-coated sheet 'BURmastic Composite Ply HT' by Tremco Canada.

- .6 Adhesive for Roofing Membranes and Ballast: Asbestos-free, cold-process asphalt adhesive 'BURmastic Adhesive' by Tremco Canada.
- .7 Flexible Flashing Membrane: 1.14 mm thick, reinforced EPDM/SBR elastomeric sheeting 'TRA' by Tremco Canada.
- .8 Adhesive for Flashing Membranes: Cold-applied elastomeric bedding adhesive compatible with elastomeric flashing 'Sheeting Bond' by Tremco Canada
- .9 Cant strip: 75 x 75 mm, purpose made asphalt impregnated wood fibreboard.
- .10 Stripping Membrane: Vinyl-coated fibreglass mesh 'Burmash' by Tremco Canada.
- .11 Stripping Adhesive: Single-component bitumen modified polyurethane, vertical grade, 'Tremlar LRM-V' by Tremco Canada.
- .12 Termination Bar: 3 mm thick aluminum bar, 25 mm wide profile, pre-drilled for mechanical attachment.
- .13 Roof gravel: Pea gravel free of fines, long splinters, dust or foreign matter, nominal 9 mm diameter.
- .14 Roof drains: In accordance with Division 22 - Mechanical
- .15 Stack flashing units: In accordance with Division 22 - Mechanical
- .16 Precast Pavers: 610 X 610 x 45 mm thick non-interlocking roof slabs, less than 5% absorption, minimum 55MPa compressive strength, standard diamond finish, chamfered edges, patio quality, conforming to CSA A231.1/A231.2. 'Diamond' concrete roof slab by armtec Brooklin or approved alternative.
- .17 Pedestals: Provide pedestals at each corner of paving slabs to product a level, smooth surface for pedestrian traffic; 'Pave-el' by Envirospec Inc. or approved alternative by Bison.

2.3 **QUANTITIES OF MATERIALS**

- .1 Following quantities of materials are required for each square metre of roofing. Tolerance of 10% maximum will be permitted.
- .2 Single ply base sheet, three ply asphalt felt, asphalt and gravel, double pour:
 - .1 1 ply base sheet at 0.5 kg per ply 0.50 kg
 - .2 3 plies roofing felt at 0.5 kg per ply 1.50 kg
 - .3 4 mop coats of asphalt at 1.2 kg per coat 4.80 kg
 - .4 1st. pour coat of asphalt at 3.0 kg 3.00 kg
 - .5 1st. gravel coat, asphalt at 20.0 kg 20.00 kg
 - .6 2nd. pour coat, asphalt at 3.0 kg 3.00 kg
 - .7 2nd gravel coat at 20.0 kg 20.00 kg

Total 52.80 kg

3 Execution

3.1 **EXAMINATION**

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

3.2 **PREPARATION**

- .1 Prior to commencement of work ensure:
 - .1 Decks are firm, straight, smooth, dry, free of snow, ice or frost, swept clean of dust and debris and properly graded to outlets.
 - .2 Wood blockings and curbs are installed and correct. Do not install roofing over such items if method of attachment is inadequate to withstand stresses imposed by thermal movement of roofing components.
- .2 Supply to trades concerned in ample time, inserts, reglets and accessories to be built into work. Assist in setting such items.
- .3 Cooperate with respective trades to determine methods and procedures to ensure watertight junctions to items passing through roof.
- .4 Do not use direct fired equipment.
- .5 Use only kettles equipped with thermometers or gauges in good working order.
- .6 Locate kettles in a safe place outside of building. When locating kettles, give consideration to direction of prevailing winds, building fans and air handling units to minimize possibility of smoke and fumes entering surrounding occupied buildings. If wind direction causes smoke and fume problems, relocate kettles on a daily basis as directed by the Consultant.
- .7 Maintain supervision while kettles are in operation and maintain metal covers for kettles to smother flames in case of fire. Supply suitable fire extinguishers.
- .8 Maintain efficiency of equipment by frequent cleaning. Remove carbonized bitumen.
- .9 Control heating of bitumen, prevent overheating. Maintain an accurate, easily read thermometer during heating. Comply with the following bitumen heating tolerances:
 - .1 Maximum heating temperature: 240°C.
 - .2 Application temperature: Equiviscous Temperature (EVT).
 - .3 Kettles: Holding time maximum 4 hours at maximum 177°C.
- .10 Use heating equipment equipped with thermometers which show temperature of asphalt at all times. During cold weather however, it may become necessary to heat bitumen beyond the normal temperatures specified herein, to obtain EVT temperature range at point of application on roof. If such conditions occur, implement cold weather procedures, and before proceeding with higher temperatures, obtain prior review from Consultant and inspection authorities approval, and take necessary safety precautions.

- .11 In cold weather insulate hauling equipment and re-circulation lines to minimize heat loss.

3.3 **DECK SHEATHING**

- .1 Over metal deck, install sheathing in straight parallel rows, with long dimension perpendicular to metal roof deck rib direction, and with short dimension edges centred on and supported by ribs of metal deck in both directions.
- .2 Place sheathing in moderately tight contact at joints between boards and abutting surfaces with gaps between boards not exceeding 3 mm.
- .3 Adhere or fasten sheathing to metal deck with in accordance with sheathing manufacturer's and adhesive manufacturer's written instructions. Sheathing to be fastened except in Gym where there is exposed metal deck.

3.4 **PRIMING**

- .1 Perform priming for asphalt roofing in accordance with CGSB 37-GP-15M.
- .2 Apply primer to deck, sheathing and vertical surfaces at rate specified by material manufacturer.

3.5 **VAPOUR RETARDER**

- .1 Install two ply vapour retarder in full mopping of asphalt. Lay plies so that flow of water is over or parallel to laps, but is never against laps. Immediately followed by full felt width squeegee pass while bitumen is within EVT temperature range plus or minus 140C as shown on manufacturer's label and/or certificate of physical properties. Ensure continuous embedment of felts and remove air pockets.
- .2 Install starter and edging strips at beginning and ends of roof area.
- .3 Lay proper number of felt plies in shingle fashion, lapped 150 mm at ends, in full moppings of hot bitumen applied at rate of 1.2 kg/m². Completely seal end laps with hot bitumen.
- .4 Apply bitumen for full and complete moppings and that felt does not touch felt, with residual bitumen evident continuously along laps. Make laps free of fishmouths.
- .5 At junction of deck to vertical surfaces and along perimeter of roof deck, extend vapour retarder, set in adhesive, beyond the point where insulation will terminate.
- .6 Seal penetrations, end and side laps, and ends of vapour retarder to substrates and to wall system air/vapour retarder to maintain continuity of building air/vapour retarder system.

3.6 **INSULATION**

- .1 Prior to installation of insulation, examine vapour retarder and make good damage.

- .2 Use full size insulation boards wherever possible, and minimum half boards at abutting vertical surfaces.
- .3 Install insulation promptly to avoid possibility of condensation beneath vapour retarder.
- .4 Install insulation in straight parallel rows, with long dimension parallel to long dimension of roof. Stagger end joints of insulation boards in adjacent rows 50%.
- .5 Place insulation boards in moderately tight contact at joints between boards and abutting surfaces with gaps between boards not exceeding 1.5 mm. Under no circumstances shall the roofing membrane be left unsupported over a space greater than 3 mm.
- .6 When cutting insulation board cut completely through board thickness; do not break or tear insulation board to fit a detail. Any areas of insulation system having voids will be rejected.
- .7 When installing multiple layers of insulation, all joints between layers shall be staggered at least 300 mm.
- .8 Do not lay more insulation than can be completely covered as finished roofing system on the same day.
- .9 Do not cut off insulation in straight lines at the end of a work period, allow stepped boards for tothing-in.
- .10 Install Polyisocyanurate insulation in a minimum of two layers.
- .11 Install Polyisocyanurate insulation, in full moppings of asphalt, in straight parallel rows, with long dimension parallel to long dimensions of insulation.
- .12 Install subsequent layers of insulation, in full moppings of asphalt, in straight parallel rows, with long dimension parallel to long dimensions of insulation.
- .13 Install tapered insulation in accordance with manufacturer's details and instructions. Miter roof insulation edges at ridge, valley and other similar non-planar conditions.
- .14 Install coverboard insulation over tapered insulation in straight parallel rows, with long dimension parallel to long dimensions of insulation. Stagger side joints in adjacent rows minimum 50%.
- .15 Install cant in full moppings of asphalt.

3.7 **MEMBRANE INSTALLATION**

- .1 Lay base sheet and plies so that flow of water is over or parallel to laps, but is never against laps. Immediately followed by full felt width squeegee pass while bitumen is within EVT temperature range plus or minus 14°C as shown on manufacturer's label and/or certificate of physical properties. Ensure continuous embedment of roofing base sheet and plies and remove air pockets.

- .2 Install starter and edging strips at beginning and ends of roof area. Extend roofing plies to top of cant strips.
- .3 Install roofing so that no more than a one hour delay occurs between application of the base sheet and fourth ply in any one location.
- .4 Lay proper number of felt plies in shingle fashion, lapped 150 mm at ends, in full moppings of hot bitumen applied at rate of 1.2 kg/m². Completely seal end laps with hot bitumen.
- .5 Apply bitumen for full and complete moppings and that felt does not touch felt, with residual bitumen evident continuously along laps. Make laps free of fishmouths.
- .6 Temporarily block drain pipes during the application of ballast or other materials which might block drains. Remove blocking when work is not in progress to prevent flooding.
- .7 Over the entire roof surface, pour a continuous and heavy coating of SEBS asphalt at 3 kg/m² into which while hot, place not less than 24.4 kg/m² of aggregate.
- .8 Except over roof areas with slopes that exceed 1:25 apply a second application of asphalt and gravel, at a rate of 20 kg/m² of gravel and 3 kg/m² of asphalt.
- .9 Membrane having air pocket voids, or which is applied at variance to these Specifications will be rejected. Remove such rejected work and replace with work which complies to Specifications, at no cost to Owner.
- .10 At end of each day's work or when stoppage occurs due to inclement weather, install water cut-offs and protection for completed work and materials out of storage.

3.8 **EXPANSION JOINT**

- .1 Cut installed roof membrane along building expansion joint.
- .2 Roll out expansion joint and allow to relax prior to installation. Ensure joint is clean and packed with batt insulation. Install expansion joint in accordance with manufacturer's instructions to ensure joint is watertight.
- .3 Apply flood coat of asphalt to roof and unroll expansion joint into it. Press expansion joint into hot asphalt with smoothing motion.
- .4 Strip in joint in accordance with manufacturer's written instructions.
- .5 Provide additional protection coarse over flashing by mopping a additional strip of modified bitumen flashing membrane on one side of expansion joint to lay completely over joint.

3.9 FLASHING INSTALLATION

- .1 Base flashing:
 - .1 Lay base flashings in vertical strips 1000 mm wide to curb surfaces as shown.
 - .2 Extend on to flat roof surface minimum 100 mm from toe of cant.
 - .3 Make 75 mm side laps and 100 mm end laps from laps in base sheet of roof membrane.
 - .4 Mop base layer of flexible flashing over 3 ply bituminous flashings up vertical surfaces and out over the deck 150 mm from toe of cant strip, using Type 3 asphalt.
- .2 Install flexible flashing sheet at roof edges and at penetrations through roof. Secure to substrates according to roofing manufacturer's written instructions.
- .3 Prime substrates with primer as required.
- .4 Flashings shall extend a minimum of 150 mm beyond toe of cant and leading edge to be concealed with reinforcing mesh and surfacing asphalt.
- .5 Unless stated otherwise, extend base flashing up walls or parapets a minimum of 300 mm above insulation and 150 mm onto field of roofing.
- .6 Mechanically fasten top of base flashing securely at terminations and perimeter of roofing. Termination bars must be applied same day as flashings are applied.
- .7 Overcoat termination bar to prevent any moisture infiltration.
- .8 Hand press flashing membrane into adhesive to ensure full adhesion is achieved.
- .9 Reinforce all vertical seams with polymer-modified mastic and reinforcing mesh. Reinforcement must carry entire length of membrane seam.
- .10 Reinforce leading edge of flashing membrane with application of reinforcing mesh mopped in polymer-modified asphalt.
- .11 Seal top termination of base flashing with a metal termination bar.
- .12 Where flashing membrane extend and terminated vertically beyond 300 mm, utilize cold-applied flashing adhesive.
- .13 Flashing Membrane to be adhered in polymer-modified asphalt.
- .14 Install flexible flashing free of blisters, sags, wrinkles and fishmouths in accordance with the manufacturer's recommendations. Avoid asphalt seepage at seams greater than 5 mm.

3.10 **ROOF ACCESSORIES**

- .1 Prior to application of flood coat and gravel, set roof hatches and roof penetration accessory units in accordance with manufacturer's product data. Set integral deck flange in full bed of roofing cement and strip-in with three plies of roofing membrane set in full moppings of bitumen. Extend flood coat and gravel to vertical projection of units. Install removable cap per accessory manufacturer product data as applicable.
- .2 Be responsible for making watertight joints to items projecting through or located on the roof, to acceptance of Consultant.
- .3 Roof walkway: Prior to application of flood coat and gravel, Install one 1000 mm layer of flexible flashing in locations shown on Contract Drawings. Prior to installation, mark location of walkway utilizing chalk lines. Mop flexible flashing onto roof membrane in full moppings of asphalt. Ensure that roofing membrane is not damaged during walkway installation.
- .4 Roof pavers: Install pavers on pedestals, one at each corner, in locations shown butted tightly, maximum 6 mm gap. Adjust or Shim up as required to obtain smooth surface transition from slab to slab.

3.11 **CLEANING**

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

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for modified bituminous roofing work in accordance with the Contract Documents.
- .2 Coordination with the work of Section 07 55 65 to ensure that green roof are installed over roofing membrane as required.

1.2 **REFERENCES**

- .1 ASTM C1177/C1177M, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
- .2 ASTM C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- .3 ASTM D6162/D6162M, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements.
- .4 CSA A123.4-M, Bitumen for Use in Construction of Built-Up Roof Coverings and Dampproofing and Waterproofing Systems.
- .5 CSA A123.21, Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems.
- .6 CSA A231.1/A231.2, Precast Concrete Paving Slabs/Precast Concrete Pavers.
- .7 CGSB 37-GP-9Ma, Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing.
- .8 CGSB 37-GP-15M, Application of Asphalt Primer for Asphalt Roofing, Dampproofing and Waterproofing.
- .9 CAN/ULC S107, Fire Test For Roof Coverings.
- .10 CAN/ULC S704, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced.
- .11 CRCA Roofing Manual, Canadian Roofing Contractors Association.
- .12 OIRCA, Ontario Industrial Roofing Contractors Association.

1.3 SUBMITTALS

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Systems, materials, and methods of installation proposed for use, showing system and each component. Certify compliance of each component with applicable standards.
 - .2 Submit cold weather construction procedures and methods of protection which will be initiated, installed and maintained when ambient temperature falls below 0°C.
- .2 Shop Drawings:
 - .1 Submit Shop Drawings in accordance with Section 01 33 00 indicating:
 - .1 Roof layout, sections, details, materials, fastener layout, flashings and membrane terminations, perimeter securement, vapour barrier terminations, insulation wrapping procedures, tapered insulation layout], membrane penetrations, control joints, and roof accessories.
 - .2 Methodology to meet wind uplift requirements.
- .3 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00:
 - .1 Substrate board and adhesive.
 - .2 Vapour retarder and adhesive.
 - .3 Insulation boards.
 - .4 Tapered insulation.
 - .5 Insulation overlay.
 - .6 Roofing membranes.
 - .7 Roof accessories.
- .4 Reports and Certificates:
 - .1 Submit copy of membership in good standing of OIRCA.
 - .2 Submit certification from manufacturer that roof system has a minimum Class C classification in accordance with CAN/ULC-S107.
 - .3 Submit Pre-Installation Notice (PIN): Copy to show that manufacturer's required Pre-Installation Notice (PIN) has been accepted and approved by the manufacturer.
 - .4 Submit project specific report, issued by certified material testing laboratory, confirming that proposed roofing assembly conforms to CSA A123.21. As a minimum report shall indicate uplift pressures for field of roof, perimeter of roof and corners of roof.
 - .5 Submit written inspection reports in duplicate from manufacturer, stating that materials proposed for use on this project meet criteria specified and are compatible with each other.

- .5 Project close-out submittals:
 - .1 Submit close-out submittals in accordance with Section 01 78 00.
 - .2 Submit membrane manufacturer's certificate that membrane has been installed in accordance with Contract Documents.
- .6 Extended warranties: Submit extended warranties signed and registered by the manufacturer providing the warranties in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 **QUALITY ASSURANCE**

- .1 Qualification: Perform work of this Section by a company that is a member in good standing of the Ontario Industrial Roofing Contractors Association (OIRCA) and has a minimum of 5 years proven acceptable roofing experience on installations of similar complexity and scope.
- .2 Testing: Provide flood testing conducted by an independent testing agency of the specified roofing products.
- .3 Perform roofing work in accordance with the CRCA Roofing Specifications Manual and in accordance with membrane manufacturer's printed installation instructions.
- .4 Ensure roofing system has been tested and conforms to CAN/CSA A123.21 to ensure wind uplift resistant applicable to the Place of Work.
- .5 Roof system shall have a minimum Class C classification in accordance with CAN/ULC-S107.
- .6 Ensure torching is performed by skilled workers who have successfully completed and passed a course of instruction by membrane manufacturer in torch-applied-membrane techniques.
- .7 Ensure membrane manufacturer's representative has full access to this work for proper inspection prior to and during membrane installation. Roof inspections shall be conducted when the roof is 10%, 50%, and 100% complete minimum. Membrane manufacturer to certify that roof installation was in conformance to manufacturer's written requirements.
- .8 Pre-installation meetings: Arrange meeting on Site to be attended by Consultant, Contractor, and roofing manufacturer's representative to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver, store and handle Products in accordance with Section 01 78 00 and as specified herein.
- .2 Deliver Products in original containers and keep in protective storage until used.

- .3 Indicate on containers or wrappings of Products:
 - .1 Manufacturer's name and brand.
 - .2 Compliance with applicable standard.
 - .3 Weight of material, where applicable.
- .4 Handle and store Products to prevent damage. Keep manufacturer's labels and seals intact. Store roofing rolls on end to prevent flattening. Ensure that shelf life of Products has not expired.
- .5 Protect Products from inclement weather. Keep insulation, insulation overlay, and roofing membranes absolutely dry. Remove from storage only as much Product as can be applied, made weathertight, and covered with roofing in same day. Do not install Products which are damp at time of installation or showing evidence of having been damp or exposed to moisture.
- .6 Store roofing membranes for 24 hours minimum in area kept at 10°C minimum and remove for application with minimum exposure to low temperatures. Keep membranes dry, stored off-the-ground, on end and well ventilated.
- .7 Do not store more than one day's supply of Products on the roof at any time. Stack materials on pallets on roof. Cover Products with incombustible waterproof tarpaulin whenever work is interrupted, or when there is precipitation of any kind.
- .8 Distribute Products stored on roof. Install bases under equipment and Products to distribute weight. Do not store Products on, or transport materials across, completed roof areas.
- .9 Place 19 mm thick plywood runways over work to enable movement of Products and other traffic.
- .10 Where hoisting or pumping occurs adjacent to construction, hang tarpaulins to protect walls and other surfaces. Locate kettle so smoke will not discolour adjacent building surfaces.
- .11 Locate a 9 kg fire extinguisher fully charged and in operable condition at installation location, of proper type for Products being used and stored.
- .12 Cover walls and adjacent work where Products are hoisted or used.
- .13 Use warning signs and barriers and maintain in good order until completion of work.
- .14 Clean off drips and smears of bituminous immediately.
- .15 Dispose of rain water off roof and away from face of building until roof drainage system has been installed and connected.
- .16 At end of each day's work or when stoppage occurs due to inclement weather, protect completed work and Products.

1.6 **SITE CONDITIONS**

- .1 Install roofing on dry deck, free of snow and ice, use only dry Products and apply only during weather that will not introduce moisture into roofing system.
- .2 Apply roofing only when air and surface temperatures are above 4⁰C, have been so for at least 48 hours and are not likely to go below 4⁰C, until work is completed.
- .3 Proceed with work when temperatures are below 4⁰C only with mutual documented agreement between Contractor and Consultant.

1.7 **EXTENDED WARRANTY**

- .1 At completion of this work, provide a signed OIRCA warranty to the Owner covering defects of workmanship for a period of 2 years commencing from date. Agree to make good promptly any defects which occur or become apparent within the warranty period in conjunction with the membrane manufacture's warranty. Defects shall include but not be limited to leakage, failure to stay in place, lifting, and deformation.
- .2 At completion of this work, provide a signed warranty from the roofing system manufacturer to the Owner covering defects in workmanship and materials for a period of 5 years commencing from date. Warranty shall include vapour retarder, membrane, roof insulation, sloped insulation, and all other products supplied by roofing system manufacturer. Scope of coverage: Repair and/or replace damaged roofing material caused by the ordinary wear and tear of the elements, manufacturing defect, and the workmanship used to install these materials.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

- .1 Acceptable membrane manufacturers:
 - .1 Henry Company Canada Inc. (Henry)
 - .2 IKO Industries Inc. (IKO)
 - .3 Soprema Waterproofing Inc. (Soprema)

2.2 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, adhesives and primers are to have low VOC content limits.
- .2 Deck Sheathing:
 - .1 Gypsum based, glass mat reinforced, moisture resistant, non-combustible conforming to ASTM C1177/C1177M.
 - .2 Thickness: 15.9 mm.
 - .3 Moisture Absorption Rate: 5% or less by weight.

- .4 Flame spread: 0; Smoke developed: 0 in accordance with CAN/ULC-S102.2.
- .5 Mold growth: 10 in accordance with ASTM D3273.
- .6 Acceptable Product: 'DensDeck Prime with EONIC™ Technology' by Georgia-Pacific Canada LP or approved alternative by CGC.
- .3 Sheathing and insulation adhesive: Single component polyurethane adhesive as recommended by roof system manufacturer.
- .4 Vapour retarder: Minimum 0.8 mm thick self adhesive membrane consisting of SBS modified bitumen adhesive bottom and tri-laminated woven polyethylene top with silicone release film. 'Vapour Block SA' by Henry, 'M.V.P.' by IKO, or 'Sopravap'r by Soprema.
- .5 Insulation:
 - .1 Polyisocyanurate insulation: CAN/ULC S704, rigid, closed cell, polyisocyanurate foam insulation integrally laminated to perforated black glass reinforced felt facers, square edges, thickness as indicated on Drawings, use maximum size board possible. Insulation thickness under 50 mm use single layer board. Insulation thickness over 50 mm use two equal thickness boards.
 - .2 Tapered Insulation: Factory pre-engineered tapered polyisocyanurate insulation in thickness sufficient for slopes indicated; manufactured by Accu-Plane Systems Inc. IKO, Posi-Slope Manufacturing Ltd. or Soprema.
- .6 Overlay board: Bituminous Board; Multi-ply, semi-rigid asphaltic roofing substrate board composed of a mineral fortified asphaltic core formed between two asphaltic saturated fibreglass liners. 1200 x 1500 x 3.2 mm thick; 'IKO Protection Board' by IKO or 'Sopraboard' by Soprema or approved alternate.
- .7 Base sheet membrane and flashing: ASTM D6162, Type 1, Grade S, Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, non-woven polyester and glass fiber composite reinforcing, having the following minimum characteristics:
 - .1 Thickness: 2.5 mm.
 - .2 Reinforcing fabric weight: 200 g/m².
 - .3 Cold flex: -18 deg. C.
 - .4 Tensile strength: 8.5 kN/m.
 - .5 Ultimate elongation: 38%.
 - .6 Tensile-tear: 246 N.
 - .7 Bottom and top surfaces: Self Adhesive/Polyethylene.
- .8 Cap sheet membrane and flashing: ASTM D6162, Type 1, Grade G, Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, non-woven polyester and glass fiber composite reinforcing, having the following minimum characteristics:
 - .1 Thickness: 3.8 mm.
 - .2 Reinforcing fabric weight: 160 g/m².
 - .3 Cold flex: -20 deg. C.
 - .4 Demensional Stability: 0.2%.

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- .5 Peak load: 20 kN/m.
 - .6 Ultimate elongation: 82%.
 - .7 Tensile-tear: 690 N.
 - .8 Granule loss: 2.0 g maximum.
 - .9 Bottom and top surfaces: Self adhesive/Granules.
 - .10 Top surface to providing a minimum SRI of 78.
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- .9 Expansion Joints: 2.2 mm thick, waterproof expansion joint in width to suit expansion joint width. 'Redline' by Situra Inc. or approved alternative.
 - .10 Plastic cement: Trowel grade asphalt mastic.
 - .11 Roofing nails: Galvanized steel, minimum 19 mm head of length to penetrate wood nailer minimum 19 mm.
 - .12 Insulation fasteners and plates: Conforming to manufacturers recommended layout for wind uplift and corrosion resistance, furnish fasteners of length required by insulation thickness plus 25 mm max.
 - .13 Roof drains: In accordance with Division 22 - Mechanical.
 - .14 Stack flashing units: In accordance with Division 22 - Mechanical.
 - .15 Precast Pavers: 610 X 610 x 45 mm thick non-interlocking roof slabs, less than 5% absorption, minimum 55MPa compressive strength, standard diamond finish, chamfered edges, patio quality, conforming to CSA A231.1/A231.2. 'Diamond' concrete roof slab by armtec Brooklin or approved alternative.
 - .16 Wood deck tiles: 'Wood tiles' by Bison Innovative Products or approved alternative.
 - .17 Pedestals: Provide pedestals at each corner of paving slabs to product a level, smooth surface for pedestrian traffic; 'Pave-el' by Envirospec Inc. or approved alternative by Bison.
 - .18 Roof hatch: Preassembled 915 x 762 mm single leaf metal roof scuttle. EPDM rubber gasket adhered to hollow metal cover. Insulation 25 mm thick with metal liner protector. 305 mm high curb with integral flashing and full welded corners. Lifting mechanism will be compression spring operators enclosed in telescopic tubes. Slam latch with interior and exterior turn handles and padlock hasps. 'Type S' by Bilco or approved alternative.
 - .19 Roof hatch safety railing: Powder coated aluminum posts and rails in high visibility, safety yellow colour. Aluminum extrusion mounting brackets and cast aluminum locking mechanism. All fasteners and hinges are type 316 stainless steel. 'Bil-Guard 2.0' by Bilco or approved alternative.

- .20 Roof hatch safety post: High strength square steel post with high visibility, powder coat finish in safety yellow colour. Design post to automatically lock into position when fully extended and to have release lever to disengage. All fasteners are type 316 stainless steel. 'LadderUp' by Bilco or approved alternative.

3 Execution

3.1 EXAMINATION

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

3.2 PREPARATION

- .1 Prior to commencement of work ensure:
 - .1 Environmental and Site conditions are suitable for material installation in accordance with manufacturer's recommendations.
 - .2 Decks are sound, straight, smooth, dry, free of oils, grease, snow, ice or frost, and swept clean of dust and debris.
 - .3 Curbs have been built and plywood and lumber nailer plates have been installed.
- .2 Supply to trades concerned in ample time, inserts, reglets and accessories to be built into Work. Assist in setting such items.
- .3 Cooperate with respective trades to determine methods and procedures to ensure watertight junctions to items passing through roof.

3.3 DECK SHEATHING

- .1 Over metal deck, Install sheathing in straight parallel rows, with long dimension perpendicular to metal roof deck rib direction, and with short dimension edges centred on and supported by ribs of metal deck in both directions.
- .2 Place sheathing in moderately tight contact at joints between boards and abutting surfaces with gaps between boards not exceeding 3 mm. Under no circumstances shall the roofing membrane be left unsupported over a space greater than 3 mm.
- .3 Adhesively fasten sheathing to metal deck with in accordance with sheathing manufacturer's and adhesive manufacturer's written instructions.

3.4 PRIMING

- .1 Perform priming at rate and to surfaces recommended by the manufacturer in accordance with CGSB 37-GP-15M.

3.5 VAPOUR RETARDER

- .1 Primer substrate to manufacturers recommendations.
- .2 Install vapour retarder in accordance with manufacturers written instructions.
- .3 Lap vapour retarder ends and edges 50 mm minimum. Roll vapour retarder and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.
- .4 Cut and fit vapour retarder as required for passage of protrusions, ensuring continuous adherence to substrate.
- .5 At junction of deck to vertical surfaces and along perimeter of roof deck, extend vapour retarder, set in adhesive, beyond the point where insulation will terminate.
- .6 Seal penetrations, end and side laps, and ends of vapour retarder to substrates and to wall system air/vapour retarder to maintain continuity of building air/vapour retarder system.

3.6 INSULATION

- .1 Prior to installation of insulation, examine vapour retarder and make good damage.
- .2 Use full size insulation boards wherever possible, and minimum half boards at abutting vertical surfaces.
- .3 Install insulation promptly to avoid possibility of condensation beneath vapour retarder.
- .4 Install insulation in straight parallel rows, with long dimension parallel to long dimension of roof. Stagger end joints of insulation boards in adjacent rows 50%.
- .5 Place insulation boards in moderately tight contact at joints between boards and abutting surfaces with gaps between boards not exceeding 1.5 mm. Under no circumstances shall the roofing membrane be left unsupported over a space greater than 3 mm.
- .6 When cutting insulation board cut completely through board thickness; do not break or tear insulation board to fit a detail. Any areas of insulation system having voids will be rejected.
- .7 When installing multiple layers of insulation, all joints between layers shall be staggered at least 300 mm.
- .8 Do not lay more insulation than can be completely covered as finished roofing system on the same day.

- .9 Do not cut off insulation in straight lines at the end of a work period, allow stepped boards for tothing-in.
- .10 Install polyisocyanurate insulation in a minimum of two layers.
- .11 Mechanically fasten base layer of insulation to deck using screws and pressure distribution plates specified. Number and pattern of fasteners per board to meet insulation manufacturers requirements for wind uplift for project location. Install fasteners in accordance with manufacturer's installation instructions. Install fasteners so that plate bears on insulation overlay without damage to, puncturing or deformation. Partial pieces of insulation to receive average number of fasteners per area of insulation, but not less than 2 fasteners per board piece.
- .12 Install Polyisocyanurate insulation, in [adhesive] [full moppings of asphalt], in straight parallel rows, with long dimension parallel to long dimensions of roof.
- .13 Install subsequent layers of insulation, in adhesive, in straight parallel rows, with long dimension parallel to previous layer of insulation with joints offset as recommended by insulation manufacturer.
- .14 Install tapered insulation in accordance with manufacturer's details and instructions. Miter roof insulation edges at ridge, valley and other similar non-planar conditions.
- .15 Install overlay board over tapered insulation in straight parallel rows, with long dimension parallel to long dimensions of insulation. Stagger side joints in adjacent rows minimum 50%.

3.7 **MEMBRANE INSTALLATION**

- .1 Install materials in accordance with manufacturer's instructions.
- .2 Install membrane free of blisters, wrinkles and fishmouths in accordance with membrane manufacturer's instructions. Avoid asphalt seepage at seams in cap sheet greater than 5 mm.
- .3 Base sheet application:
 - .1 Unroll base sheet dry over substrates, align and reroll in halves.
 - .2 Cut release paper and peel back on section of roll to be adhered. Peel lower part of release paper back on itself.
 - .3 Unroll half of roll while removing release paper, immediately apply pressure on adhered membrane with 27 kg steel roller. Re-roll second half of roll and install in same manner as first.
 - .4 Cut off corners at end laps to be covered by subsequent rolls. Seal all joints with heat gun and rounded end trowel.
- .4 Cap sheet application:
 - .1 Clean base sheet membrane surface of all construction material, debris, dirt and dust.

- .2 Align cap sheet membrane by completely unrolling and setting roll exactly where it is to be installed. Head laps are offset a minimum of 600 mm and side laps a minimum of 300 mm from those of the base membrane.
- .3 Completely unroll cap sheet membrane and allow unrolled membrane to completely relax.
- .4 Cut release paper and peel back on section of roll to be adhered. Peel lower part of release paper back on itself.
- .5 Unroll half of roll while removing release paper, immediately apply pressure on adhered membrane with steel roller as recommended by roofing manufacturer. Re-roll second half of roll and install in same manner as first.
- .6 Side laps are sealed by removing the release film and applying firm and deliberate pressure to the lap with a hand roller, ensuring a complete bond between the two plies, without air pockets, wrinkles, fishmouths or tears.
- .7 End laps are sealed using hot air. The film must be removed at all end laps to ensure a 100% bond of bitumen-to-bitumen.
- .8 Provide a smooth application, free of wrinkles, fishmouths or air pockets.

3.8 **EXPANSION JOINT**

- .1 Roll out expansion joint and allow to relax prior to installation. Ensure joint is clean and packed with batt insulation. Install expansion joint in accordance with manufacturer's instructions to ensure joint is watertight.
- .2 Apply flood coat of asphalt to roof and unroll expansion joint into it. Press expansion joint into hot asphalt with smoothing motion.
- .3 Strip in joint by coating top side of polyester fleece with flood coat of asphalt and installing top ply of bitumen.
- .4 Provide additional protection coarse over flashing by mopping a additional strip of modified bitumen membrane on one side of expansion joint to lay completely over joint.

3.9 **FLASHING INSTALLATION**

- .1 Install flashing free of blisters, sags, wrinkles and fishmouths in accordance with the manufacturer's recommendations. Avoid asphalt seepage at seams greater than 5 mm.
- .2 Base flashing:
 - .1 Apply primer to substrate.
 - .2 Lay base flashings in vertical strips 1000 mm wide to curb surfaces as shown.
 - .3 Extend on to flat roof surface minimum 100 mm from toe of cant.
 - .4 Make 75 mm side laps and 100 mm end laps from laps in base sheet of roof membrane.
 - .5 Install flashings by removing release paper and pressing onto substrate proceeding from top to bottom, heat weld base sheet where flashing overlaps.

- .6 Apply uniform pressure over flashing surface and seal seams with rubber roller.
- .7 Nail top leading edge to nailer at 300 mm o.c. seal all joints with weld gun and rounded end trowel.
- .8 Cut off corners at end laps to be covered by subsequent rolls of flashing.
- .3 Cap flashing:
 - .1 Clean base sheet flashing surfaces of all construction material, debris, dirt and dust. Apply primer as recommended by roofing manufacturer before applying the cap sheet flashings.
 - .2 Unroll cap flashing and apply firmly onto base sheet flashing. Immediately apply firm and deliberate pressure by slowly rolling a manufacturer recommended roller over entire surface of the installed flashing to ensure a complete bond to the substrate.
 - .3 Make 75 mm side laps and 100 mm end laps from cap sheet laps and base flashing laps. Heat or hot-air weld side laps, without overheating, as required for uniform adhesion over surface of base flashing.
 - .4 Provide a smooth application, free of wrinkles, fishmouths or air pockets.

3.10 **ROOF ACCESSORIES**

- .1 Prior to application of membrane set stack flashing units, roof hatch, prefabricated equipment curbs, and other roof penetration accessory units in accordance with manufacturer's Product data. Install removable cap per accessory manufacturer's Product data as applicable.
- .2 Seal joints at items projecting through membrane watertight to acceptance of Consultant.
- .3 Roof pavers: Install pavers on pedestals, one at each corner, in locations shown butted tightly, maximum 6 mm gap. Adjust or Shim up as required to obtain smooth surface transition from slab to slab.

3.11 **FIELD QUALITY CONTROL**

- .1 Check completed membrane welds for continuity after cooling by use of screw driver run along welded seams and showing uninterrupted extrusion of melted asphalt material.
- .2 Inspect completed membrane and flashings for punctures, tears and discontinuous weld seams. Apply additional layer of cap sheet membrane over punctures and tears, extending beyond damaged area or open seam in all directions, torch in-place.

3.12 **CLEANING**

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

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for green roof system work in accordance with the Contract Documents.
- .2 Coordination with the work of Section 07 52 00 for roof installation and scheduling.

1.2 **REFERENCES**

- .1 ANSI/SPRI RP-4, Wind Design Standard For Ballasted Single-Ply Roofing Systems.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Systems, materials, and methods of installation proposed for use, showing system and each component. Wind uplift and ballast requirements. Certify compliance of each component with applicable standards.
 - .2 Submit cold weather construction procedures and methods of protection which will be initiated, installed and maintained when ambient temperature falls below 0°C.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .2 Wind uplift and ballast requirements, details of connections, layout, types of plantings and similar items.
- .3 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00.
 - .1 Planting module and mat complete with type of planting mix required.
 - .2 Metal edging.
- .4 Certificates: Submit manufacturer's certification that wind uplift and ballast design requirements are approved for this specific installation.
- .5 Project close-out submittals:
 - .1 Submit close-out submittals in accordance with Section 01 78 00.
 - .2 Submit maintenance guidelines and most current data sheets.
- .6 Extended warranties: Submit extended warranties signed and registered by the manufacturer providing the warranties in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 **QUALITY ASSURANCE**

- .1 Design green roof system wind uplift and ballast requirements in accordance with ANSI/SPRI RP-4, insulation manufacturer's requirements, and authorities having jurisdiction.
- .2 Nursery Qualifications: Company specializing in growing and cultivating of plants with a minimum 10 years of documented experience, approved by Consultant.
- .3 Maintenance Services: Perennial and groundcover maintenance must be performed by a certified horticulturalist.
- .4 Verification of Structural Capacity: Prior to ordering products obtain written confirmation from owner-mandated professional engineer certifying that structure is capable of bearing additional load of green roof system.
- .5 Vegetation guarantee: Provide written statement from manufacturer guaranteeing a minimum of 95% vegetated coverage at time of installation pre-planted 10 weeks prior to installation on roof.
- .6 Pre-installation meetings: Arrange meeting on Site to be attended by Consultant, Contractor, and roofing manufacturer's representative to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- .1 Pre-cultivated plant material shall be delivered in such a manner as to preserve quality of plants (e.g. refrigerated container).
- .2 Upon arrival to site, trays shall be immediately removed from delivery truck and utilized on roof on same day. If roof is not sufficiently prepared for installation of tray, then prepare holding area to store trays without being stacked.
- .3 Non-living components (root barrier, drainage, and fleece) can be stored on site, but must be protected from the elements by covering with a water-resistant tarpaulin.

1.6 **EXTENDED WARRANTY**

- .1 Submit an extended written warranty for green roof [modules] [mats] in accordance with the General Conditions, except that warranty period is extended to 2 years from date.
- .2 Plants shall be in healthy growing condition by end of warranty period. Plants with dead or dying branches, which in the opinion of the Consultant are sufficient to detract from the character and form of the plant, will not be accepted. Replacements required during warranty period shall be plants of the same kind and size as shown on the plant list and on the drawings, furnished and planted as specified in the Ready-for-Takeover.. The cost of replacement shall be the responsibility of the Contractor.

2 Products

2.1 **MATERIALS**

- .1 Modules: 300 mm x 600 mm x 75 mm high x 100 mil. thick recycled polypropylene pans complete with 140 mm tall x 45 mil. thick removable insert collar to allow for growing soil above container edge. Saturated weight with mature vegetation shall be approximately 40-50 lb. per square ft. 'LiveRoof Deep' by LiveRoof Green Roof Plants or approved alternative.
- .2 Growing medium: Engineered blend of inorganic and organic components.
- .3 Vegetation: All plants will be No. 1 grade nursery stock grown and supplied in accordance with current standards as adopted by the Canadian Nursery Trades Association. Refer to drawings for planting schedule and module planting mixes.
 - .1 Plants shall be healthy, vigorous, and grown in a recognized nursery in accordance with good horticultural practice and free of disease, insects, eggs, larvae and defects.
 - .2 Plants shall be in full accordance with drawings.
 - .3 Ensure coordination of planting of individual modules with the overall planting plan.
- .4 Metal edging: Non-fastened co-engineered aluminium slotted edging in clear anodized finish. Provide linear pieces and 90 degree corner pieces as need to contain areas as indicated on drawings. 'Permaloc' by Liveroof complete with Tek screw fasteners.
- .5 Root barrier protection: 30 mil thick low density polyethylene sheet. 'XF 112' by Xeroflor Canada Inc., or approved alternative by Vitaroofs International Inc.
- .6 Drainage mat: Flexible, non-woven, entangled polymeric filaments with geotextile filtration fabric bonded to one side. 'XF 108H' by Xeroflor Canada Inc., or approved alternative by Vitaroofs International Inc.
- .7 Water retention mat: Recycled, synthetic fiber mat with a maximum saturated weight of 7.4 kg/m². 'XF 159' by Xeroflor Canada Inc., or approved alternative by Vitaroofs International Inc.
- .8 Vegetation blanket: Pre-cultivated blanket consisting of fleece with nylon slings filled with planting substrate, with lightweight fleece underneath. The vegetation stock is mainly formed by sedum plants (minimum 8 sedum species). 'XF 301' by Xeroflor Canada Inc., or approved alternative by Vitaroofs International Inc.

3 Execution

3.1 **EXAMINATION**

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

3.2 **SUBSTRATE PREPARATION AND PROTECTION**

- .1 The surface of the roof shall be free of debris and swept prior to installing green roof components.
- .2 Contractor accepts full responsibility for all green roof installation work completed prior to the proper operation of an irrigation system.
- .3 When moving materials on roofs or installing green roof systems, protect exposed work surfaces to avoid damage. Use sturdy panelling to erect rooftop footpaths so as to cover materials installed and permit foot traffic and movement of new materials. The contracted installer is fully responsible for any damage.
- .4 Ensure additional layer of roofing membrane has been provided with edges overlapped and bonded to protect roofing membrane.

3.3 **MODULE INSTALLATION**

- .1 Weight of module system to be installed to be in accordance with reviewed shop drawings and manufacturer's written requirements.
- .2 Green roof system installation to commence only once curbs and edging have been installed.
- .3 Install modules over root barrier in accordance with manufacturers' written recommendations.
- .4 Uniformly distribute range of planting mix modules over total area of work as indicated on drawings.
- .5 Water modules promptly after installation to thoroughly moisten media from top to bottom. Water shall be of suitable quality for plant growth.
- .6 Roof Edges, Drains and other Penetrations
 - .1 Maintain a distances as indicated on drawings.
 - .2 Cut modules to conform to plan layout.

3.4 **MAT INSTALLATION**

- .1 Weight of mat system to be installed to be in accordance with reviewed shop drawings and manufacturer's written requirements.
- .2 Loose lay root barrier, lapping all sides and ends a minimum of 250 mm and staggering all ends laps.
- .3 Install mats with geotextile fabric facing up, overlapping additional 100 mm wide fabric at edges and staggering end joints of mats.
- .4 Roll out and loose lay retention fleece over drainage mat tightly butted together, staggering adjacent rolls.
- .5 Roll out and loose lay over water retention mat.
- .6 Water vegetation mat throughly in accordance with manufacturer's written instructions.

3.5 **MAINTENANCE DURING CONSTRUCTION**

- .1 Contractor shall be responsible for interim maintenance of plant material up to point of final acceptance and client maintenance take-over and such maintenance shall be considered part of installation.
- .2 Contractor must immediately replace all dead or dying plants as required by Consultant. Replacement of plants only at end of warranty period will not be acceptable.
- .3 Interim maintenance for new planting shall consist of:
 - .1 Pruning, watering, fertilizing, cultivating, weeding, mulching, resetting plants to proper grades or upright position, restoration of planting beds, furnishing and application of such sprays and protective barriers as are necessary to keep plants free of insects, rodents, diseases and such maintenance as required at direction of Consultant.
 - .2 Keeping planting beds free of weeds; do not cultivate areas where groundcover is becoming established. Do not use herbicides or pesticides.

3.6 **MAINTENANCE DURING ESTABLISHMENT PERIOD**

- .1 Maintenance must be provided by green roof Contractor during the establishment period.
- .2 Maintenance shall comprise weekly inspections, and application of watering, fertilizing, weeding and infill plantings, as required to keep vegetation vigorous and healthy.

- .3 Contractor shall submit monthly reports, including list of all operations completed, including photographs.

3.7 FIELD QUALITY CONTROL

- .1 Notify Consultant 72 hours prior to completion of green roof system and arrange for job site inspection in presence of Consultant.
- .2 Contractor to schedule inspection by technical representative of green roof system to ensure system has been installed as per product specifications.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for flashing and sheet metal work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .2 ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 ASTM C1193, Standard Guide for Use of Joint Sealants.
- .4 ASTM C920, Specification for Elastomeric Joint Sealants.
- .5 CSA A123.21, Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems.
- .6 CRCA Roofing Manual, Canadian Roofing Contractors Association.

1.3 **DESIGN REQUIREMENTS**

- .1 Design flashing elements and fastenings to withstand wind loading and perimeter and corner uplift pressures for roof system in accordance with CSA A123.21.

1.4 **SUBMITTALS**

- .1 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Proposed method of shaping, forming, jointing.
 - .2 Application of flashing and sheet metal work.
 - .3 Flashing fastening method, fasteners, and fastener spacing to meet wind loading and uplift pressures.
- .2 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00:
 - .1 50 x 50 mm samples of sheet metal material, colour and finish.
 - .2 Representative sample section of prepainted metal flashing illustrating S locking jointing method, minimum 600 mm long.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, sealants and paints are to have low VOC content limits.
- .2 Prepainted sheet steel: ASTM A653/A653M; Classification LFQ, Grade A, Z275 zinc coating designation, 0.60 mm minimum base steel thickness, commercial quality, prefinished with Perspectra Series coating system by ArcelorMittal Dofasco, or WeatherX by Vicwest Steel. Colour: Refer to Material Legend as indicated on Drawings.
- .3 Aluminum flashings:
 - .1 Aluminum sheet: ASTM B209 and ANSI H35.1 AA1100 aluminum alloy, H14 temper, minimum 1.0 mm thick. Finish: 'Duranar XL' by PPG in accordance with AAMA 2605.. Colour: Refer to Material Legend as indicated on Drawings.
 - .2 Isolation coating: Alkali resistant bituminous coating; '810-07' by Henry Company Canada Inc.
- .4 Plastic cement: Trowel grade asphalt mastic.
- .5 Sealant: ASTM C920, Type S, Grade NS, Class 25; High-performance, medium-modulus, one-part, neutral-cure silicone sealant. 'Dowsil CWS' by Dow Consumer Solutions, 'Sikasil 305CN' by Sika or 'Tremsil 400' by Tremco.
- .6 Cleats and starter strips: Starter strips to be continuous, of same material as flashing used, 1.2 mm thick.
- .7 Fasteners: Flat head roofing nails of length, type and thickness suitable for metal flashing application.
- .8 Washers: of same material as sheet metal, 1 mm thick with rubber packings.
- .9 Touch-up paint: Same colour and material as prepainted sheet steel, as recommended by prefinished coating manufacturer.

2.2 **FABRICATION**

- .1 Fabricate copings, flashings, curb counter flashings, starter strips, scuppers, and miscellaneous flashings in accordance with CRCA and to details shown.
- .2 Form prepainted sheet material at shop to shapes shown. Make end joints where adjacent lengths of metal flashing meet, in accordance with jointing method specified.
- .3 Form pieces in 2400 mm maximum practical lengths. Make allowance for expansion at joints.

- .4 Hem exposed edges 13 mm minimum on underside for appearance and stiffness. Mitre and seal corners with sealant.
- .5 Reglets and Cap flashing: Form flashings of as detailed and in accordance with CRCA. Provide slotted fixing holes and steel/plastic washer fasteners.
- .6 Scuppers:
 - .1 Form scuppers from galvanized sheet metal.
 - .2 Sizes and profiles as indicated.
 - .3 Provide necessary fastenings.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Install coping flashings, curb counter flashings, starter strips, scuppers, miscellaneous flashings, and fasteners to details indicated and in accordance with reviewed shop drawings and CRCA requirements.
- .2 Use concealed fasteners. Exposed fasteners such as pop rivets are not allowed.
- .3 Install continuous starter strips to present a true, non-waving, leading edge. Anchor to back-up for a rigid, secure installation.
- .4 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs. Flash joints using S-lock forming tight fit over hook strips.
- .5 Make end joints using an S lock joint. Execute by inserting end coping length in 25 mm deep S lock formed in end of adjacent length. Extend concealed portion of S lock 25 mm outwards and nail to substrate. Face nailing of joints will not be permitted.
- .6 Seal where necessary to form weathertight seal between flashing and adjoining surfaces and between flashing and other work. Sealing work consists of bedding between members where possible. Tool sealant to concave profile where exposed. Install sealant in accordance with ASTM C1193.
- .7 Insert metal flashing under cap flashing to form weathertight junction.
- .8 Caulk flashing at cap flashing with sealant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for spray applied fireproofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM E814, Methods of Fire Tests of Through-Penetration Fire Stops.
- .2 CAN/ULC S101, Standard Methods of Fire Endurance Test of Building Construction and Materials.
- .3 CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .4 Technical Manual 12-A, Standard Practice for the Testing and Inspection of Field Applied Sprayed Fire-Resistive Materials by Association of the Wall and Ceiling Industry (AWCI).
- .5 UL 1479, Standard Method of Fire Tests of Through-Penetrations.

1.3 **DESIGN REQUIREMENTS**

- .1 Design fireproofing for structural members, floor/ceiling assemblies, and floor/roof assemblies as unrestrained unless otherwise specifically noted as restrained on the structural drawings.

1.4 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Certification:
 - .1 Submit certified documentation for each worker performing Work of this Section, to substantiate 5 years minimum of experience in sprayed fireproofing installation.
 - .2 Submit installer's and Product manufacturer's certification verifying compliance with Contract Documents.
 - .3 For assemblies not tested and rated in accordance with CAN/ULC S101 and CAN/ULC S102, submit proposals based on related designs using accepted fireproofing design criteria.

- .4 Submit manufacturer's inspection reports and verification/certification that work has been correctly installed.

1.5 **QUALITY ASSURANCE**

- .1 Qualifications: Execute work of this Section by manufacturer-approved, skilled, qualified, and experienced workers, trained in installation of work of this Section.
- .2 Regulatory Requirements: Be responsible for securing approval of materials and installation of work from authority having jurisdiction:
 - .1 Perform work in compliance with ULC or cUL listed designs for the required fire resistance ratings.
 - .2 Submit signed engineering proposals to Authority having Jurisdiction for acceptance if there are no listed designs that match project conditions.
 - .3 Perform tests required by Authorities having Jurisdiction.
- .3 Manufacturer's Site Inspection: Manufacturer's technical representative shall inspect work at suitable intervals during application and at conclusion of work of this Section, to ensure work is correctly installed.
- .4 Mock-up:
 - .1 Construct one 2 m² mock-up of fireproofing in location acceptable to Consultant.
 - .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
 - .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
 - .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

1.6 **SITE CONDITIONS**

- .1 Maintain a 5°C air and substrate temperature for 24 hours before, during, and 24 hours after application in accordance with manufacturer's instructions.
- .2 Ventilate to dry fireproofing. In enclosed areas circulate interior air and exhaust to the exterior.
- .3 Protect adjacent surfaces and equipment around application areas from overspray, marring or damage. Clean, polish or replace materials damaged to acceptance of Consultant.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers, adhesives, paints, and sealers are to have low VOC content limits.
- .2 Primer: As recommended by spray fireproofing manufacturer.
- .3 Spray fireproofing: CAN/ULC S101, Spray applied, cementitious fireproofing with a minimum density of 240 kg/m3:
 - .1 'Blaze-Shield II' by Cafco Industries Ltd.
 - .2 'Southwest Type 5GP' by A/D Fire Protection Systems Inc.
- .4 Sealer: Water based acrylic sealer in clear:
 - .1 'Bond-Seal' by Cafco Industries Ltd
 - .2 'A/D TC-55 Sealer' by A/D Fire Protection Systems Inc
- .5 Metal lath: Expanded metal lath fabricated from material of weight, configuration, and finish required to comply with fire resistance designs acceptable to Authority having Jurisdiction and fire resistive material manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive sprayed fire-resistive material.
- .6 Water: Clean, free from organic and mineral impurities which would be harmful to application.

2.2 **MIXING**

- .1 Mix Products in accordance with manufacturer's instructions.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify that substrates are compatible and have suitable bonding characteristics to receive fireproofing.
- .3 Ensure written confirmation is received from steel fabricators of the specific surface preparation procedures and primers used to ascertain compatibility with work of this Section.

- .4 Ensure that items required to penetrate fireproofing are placed before installation of fireproofing.
- .5 Ensure that ducts, piping, equipments, or other items which would interfere with application of fireproofing are not positioned until fireproofing is completed.

3.2 **PREPARATION**

- .1 Prime substrates where required by ULC or by sprayed fireproofing material manufacturer, unless compatible shop primer has been applied and is in satisfactory condition to receive work.
- .2 Clean surfaces of steel members free of dust, dirt, oil, grease, loose paint, mill scale, rust and other foreign matter in accordance with manufacturers written instructions which would interfere with bond of fireproofing. Steel to receive fireproofing should have no primers or coatings applied to the surface prior to application.
- .3 Install metal lath where required to comply with fire resistance ratings and fireproofing manufacturer's written recommendations for conditions of exposure and intended use. Securely attach lath to substrate in position required for support and reinforcement of fire-resistive material. Use anchorage devices of type recommended in writing by sprayed fire-resistive material manufacturer. Attach lathing accessories where indicated or required for secure attachment to substrate.
- .4 Coat substrates with bonding adhesive where required to achieve fire resistance rating or as recommended in writing by spray fireproofing manufacturer for material and application indicated.
- .5 Use temporary enclosures to prevent spray from contaminating air beyond application area. Protect adjacent surfaces and equipment from damage by overspray, fall-out, and dusting of fireproofing material. Protect walls, windows, floors and other surfaces around areas to be fireproofed, from marring or damage.

3.3 **APPLICATION**

- .1 Apply fireproofing in separate coats in accordance with the manufacturer's written instructions to total thickness required to achieve fire ratings shown on the Contract Drawings. Comply with accepted ULC or Intertek Testing Services design.
- .2 Apply fireproofing on steel over 2000 mm long as indicated or as required by authorities having jurisdiction.
- .3 Maintain continuity of fireproofing without gaps or voids.
- .4 Water tamping: Provide low pressure spray to finished surface of fireproofing to provide dense, medium smooth surface.
- .5 Apply sealer to surfaces of fireproofing in accordance with the manufacturer's instructions after tamping.

- .6 Repair fireproofing damaged by other trades, to acceptance of Consultant.

3.4 **FIELD QUALITY CONTROL**

- .1 Perform field tests as required by Authorities having Jurisdiction. Tests to be carried out as outlined in Technical Manual 12-A by AWCI and UL 1479.

3.5 **CLEANING UP**

- .1 Clean exposed wall, ceiling or other surfaces of fireproofing materials to the acceptance of Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for intumescent fireproofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM D2240, Standard Test Method for Rubber Property - Durometer Hardness.
- .2 ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
- .3 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .4 ASTM E761, Standard test method for Compressive Strength of Sprayed Fire-Resistive Materials Applied to Structural Members.
- .5 AWCI, Association of the Wall and Ceiling Industries - International.
- .6 AWCI Technical Manual 12-B, Standard Practice for the Testing and Inspection of Field Applied Thin-Film Intumescent Fire-Resistive Materials; an Annotated Guide.
- .7 Technical Manual 12-B, 'Standard Practice for the Testing and Inspection of Field Applied Thin-Film Intumescent Fire-Resistive Materials by Association of the Wall and Ceiling Industry (AWCI)
- .8 ULC, Underwriter's Laboratories of Canada.

1.3 **SYSTEM DESCRIPTION**

- .1 Provide intumescent fireproofing to provide a fire resistance rating of 60 minutes for all columns and items indicated on drawings.

1.4 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data for each material used in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00.
 - .1 Two 150 x 300 mm samples of intumescent fireproofing applied to 3 mm steel plate cut back to show primer, intumescent coating and topcoat demonstrating colour and finish for Consultant approval.

- .3 Certificates:
 - .1 Submit ULC certification for designs of fire resistive coating application to substrate materials required and test reports showing compliance with specified physical performance characteristics and physical properties.

1.5 **QUALITY ASSURANCE**

- .1 Installers qualifications:
 - .1 Perform work of this Section by a company that has a minimum of five years proven experience in the installation of intumescent fireproof coatings on project of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Inspection and Testing:
 - .1 An independent testing laboratory/company may be selected by the Consultant to test random samples as applied, to verify thickness of thin-film intumescent fire-resistive coating in accordance with AWCI Technical Manual 12-B. Inspection shall be carried out prior to application of topcoat.
 - .2 Correct deficiencies and have such corrected work approved by Inspection/Testing Company before work is continued.

1.6 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Ship, store and deliver at temperatures not less than 50°F (10°C); protect from freezing.
- .2 Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.7 **SITE CONDITIONS**

- .1 Do not install work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:
 - .1 Ambient air and surface temperature: 10°C minimum.
 - .2 Precipitation: None.
 - .3 Relative Humidity: 40-60%.
- .2 Do not install work of this Section outside of environmental ranges as recommended by the intumescent coating manufacturer without the Consultant's and Product manufacturer's written acceptance.
- .3 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 24 hours before, during, and 24 hours after installation.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, coatings are to have low VOC content limits.
- .2 Intumescent fireproofing system (interior): 'A/D Firefilm III System' by A/D Fire Protection Systems, 'Sprayfilm' by Cafco or approved alternative by StonCor, consisting of the following components.
 - .1 Primer: Recommended by manufacturer for substrate being fireproofed.
 - .2 Intumescent coating: A/D Firefilm III, conforming to:
 - .1 Hardness (Shore "D"): Durometer D65-70 in accordance with ASTM D2240.
 - .2 Surface Burning Characteristics: Class "A", in accordance with ASTM E84.
 - .3 Density 1425 kg/m².
 - .4 Bond strength: 861 kPa in accordance with ASTM D4541.
 - .5 Compressive strength: 5.2 MPa [109,008 psf] at 10 % deformation, in accordance with ASTM E761.
 - .3 Top coat: A/D TC-55 Sealer. Colour: Clear.
- .3 Intumescent fireproofing system (exterior): Two component, epoxy based, thermally activated, subliming coating. Intumescent coating system to include primer, intumescent coating, and top coat as indicated below.
 - .1 'Thermo-Lag 3000-SA' by A/D Fire Protection Systems or approved alternative by Cafco or approved alternative manufacturer that meets or exceeds the specifications.
 - .2 Primer: Recommended by manufacturer for substrate being fireproofed.
 - .3 Intumescent coating: Provide first and final coat of 'Thermo-Lag 3000-SA' by A/D Fire Protection Systems, meeting the following criteria:
 - .1 VOC content: 0.53 lbs/gal.
 - .2 Density: 1313 kg/cm. (82 pcf) conforming to ASTM E605.
 - .3 Hardness (Shore "D"): Durometer of 55 in accordance with ASTM D2240.
 - .4 Surface Burning Characteristics: Flame Spread: 0, Smoke Development: 0-20, Class "A", in accordance with ASTM E84.
 - .5 Bond Strength: 2.73 MPa (57,000 psf) in accordance with ASTM E736.
 - .6 Compressive strength: 19.65 MPa (2,850 psi) in accordance with ASTM E761.
 - .4 Top coat: Top coat as approved by intumescent film manufacturer for intended application. Colour to be selected by Consultant.

2.2 **MIXES**

- .1 Mix intumescent fireproof coating components in accordance with manufacturer's written instructions.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Verify that all clips, hangers, sleeves and similar devices have been attached. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

- .1 Protect work of other trades against overspray and make good at own expense any such damage. Provide adequate covering by drop cloths, masting or tarpaulins to surfaces, or on fitments in contact with, or adjacent to, surfaces to be fireproofed.
- .2 Clean surfaces, to be fireproofed, free of dust, grease, oils, etc. in accordance with manufacturer's recommendations. Ensure surfaces are free of any extraneous matter which could be detrimental to a satisfactory and acceptable finish.
- .3 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.
- .4 Prime surfaces to be fireproofed with specified primer in accordance with manufacturer's recommendations.
- .5 Inspect primed surfaces to be fireproofed for gouges, marks, pinholes, nibs, etc. Properly prepare same by patching, filling, smoothing or any other surface preparation necessary to ensure a satisfactory surface finish.
- .6 Ensure written confirmation is received from steel fabricators of the specific surface preparation procedures and primers used for the application of fireproofing materials to ascertain compatibility with work of this Section:
 - .1 Verify that substrate surfaces are ready to receive work. Commercial blast cleaning (SSPC SP6) is required for minimum surface preparation. Weld flashes should be ground smooth prior to commencement of application. Select primer from manufacturer's list of approved primers.

3.3 **APPLICATION**

- .1 Install intumescent fireproofing in accordance with manufacturer's written instructions.
- .2 Install intumescent fireproofing at the proper consistency to ensure a satisfactory surface finish.
- .3 Use-up materials within shelf life period recommended by manufacturer.
- .4 Ensure finished work is uniform as to sheen, gloss, colour, and texture.

- .5 Patching: Patch and repair any fire resistive coating that has been damaged in accordance with patching recommendations of material manufacturer. If coating becomes damaged, rebuild thickness by spray or brush. Fill small areas with trowel. When dry, smooth and finish to match adjacent surfaces.

3.4 **FIELD QUALITY CONTROL**

- .1 Perform field tests as required by Authorities having Jurisdiction. Tests to be carried out as outlined in Technical Manual 12-B by AWCI.

3.5 **CLEANING**

- .1 Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions. Remove and legally dispose of construction debris.
- .2 Work will not be considered complete until all spatters, drippings, smears and overspray have been cleaned and removed to the satisfaction of Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for firestopping and smoke seals work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM C303, Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
- .2 ASTM C920, Standard Specification for Elastomeric Joint Sealants.
- .3 ASTM C1104, Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
- .4 ASTM E814, Test Method for Fire Tests of Through-Penetration Fire Stops.
- .5 ASTM E2174, Standard Practice for On-Site Inspection of Installed Fire Stops.
- .6 CAN/ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .7 CAN/ULC S114, Standard Method of Test for Determination of Non-Combustibility in Building Materials.
- .8 CAN/ULC S115, Standard Method of Fire Tests of Firestop Systems.
- .9 CAN/ULC S129, Standard Method Of Test For Smoulder Resistance Of Insulation (Basket Method).
- .10 CAN/ULC S702, Thermal Insulation, Mineral Fibre for Buildings.

1.3 **DEFINITIONS**

- .1 Fire Separation: A construction assembly, plane or device, either vertical or horizontal, which is required to prevent the passage of fire and smoke for a prescribed period of time. Proof of compliance to required time rating shall be by ULC, Warnock Hersey (or similar approved) certification or shall be as listed in the Ontario Building Code Supplementary Standard SB-2.
- .2 Smoke Separation: A construction assembly, plane or device, either vertical or horizontal, which is not required to prevent the passage of fire for a prescribed period of time but is required to prevent the passage of smoke. A "Smoke Separation" is also known as a "Fire Separation with No Rating" or a "Zero Hour Rated Separation".
- .3 Non-Rated Separation: A construction assembly, plane or device, either vertical or horizontal, which is not required to prevent the passage of fire for a prescribed period of time and is not required to prevent the passage of smoke.

1.4 **SYSTEM DESCRIPTION**

- .1 Firestopping and smoke seals: ULC or Intertek Testing Services listed Products and systems in accordance with CAN/ULC S115 suitable to actual application and installation conditions.
- .2 Firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.
- .3 Firestop and smoke seal system shall achieve a fire resistance rating and smoke seal rating equal to that of assemblies into which they are installed.
- .4 Provide smoke sealants over firestopping materials or combination smoke seal/firestop seal material to form air tight barriers to retard the passage of gas and smoke.
- .5 Firestopping and smoke seals located at movement joints shall be designed with movement capability.
- .6 Firestopping and smoke seals within mechanical and electrical assemblies shall be provided as part of the work of Divisions 21, 22, 23, 26, 27, and 28 respectively.

1.5 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate cUL or ULC reference standard, characteristics, limitations.
 - .2 Product transportation, storage, handling and installation requirements.
 - .3 Submit firestop and smoke seal manufacturer's Product data for materials and prefabricated devices, including manufacturer's printed installation instructions.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Fire rated and smoke sealed systems for each typical application.
 - .2 Construction details, accurately reflecting actual job conditions.
 - .3 ULC or Intertek Testing assembly listing.
 - .4 Each floor and wall assembly requiring firestop system with each corresponding ULC firestop system.

- .3 Certification:
 - .1 Submit certified documentation from manufacturer for each worker performing work of this Section.
 - .2 Submit installer's and Product manufacturer's certification verifying compliance with the Contract Documents and conformance with ASTM E814 and CAN/ULC S115.

1.6 **QUALITY ASSURANCE**

- .1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of firestopping and smoke seal work of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Manufacturer's direct representative and/or fire protection specialist shall be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures conforming to manufacturer's written recommendations published in their literature and drawing details.
- .3 Pre-construction meetings: Arrange with manufacturer's representative, Contractor, Consultant and Field Engineer to determine responsibility for handling such issues as FT rated partitions, firestop custom details, compatibility, mixed penetrations, and to review installation procedures 48 hours in advance of installation.

1.7 **DELIVERY STORAGE AND HANDLING**

- .1 Deliver materials to Place of Work in manufacturer's unopened containers, containing classification label with labels intact and legible at time of use.
- .2 Do not use damaged or adulterated materials exceeding their expiry date.

1.8 **SITE CONDITIONS**

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

2 **Products**

2.1 **ACCEPTABLE MANUFACTURERS**

- .1 Acceptable manufacturers of rated systems include:
 - .1 3M
 - .2 Hilti Canada Corporation.
 - .3 Specified Technologies Inc. (STI Firestop)
 - .4 Tremco Ltd.
 - .5 Or approved alternative.

2.2 GENERAL SYSTEM REQUIREMENTS

- .1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Do not use Products containing asbestos.
- .3 Firestopping components shall not contain volatile solvents or require special application to protect plastic pipe from firestopping compound.
- .4 Provide smoke seal sealant in following colours:
 - .1 Grey or white in finished areas.
 - .2 Red in unfinished areas.
- .5 Smoke sealant for overhead and vertical joints for floor to be self-levelling and non-sagging sealant.
- .6 Smoke sealant at vertical through penetrations in areas with floor drains shall be waterproof type.

2.3 MATERIALS

- .1 Following materials have been provided for convenience. Contractor shall provide complete system with all components and accessories as required for fire resistant and smoke seal installation.
- .2 Firestop sealant: single component, low modulus, silicone rubber, moisture curing sealant to ASTM C920, ULC labelled to CAN/ULC S115.
- .3 Pre-Installed firestop devices for use with non-combustible and combustible pipes, conduit and/or cable bundles penetrating concrete floors and walls.
 - .1 Cast-in place firestop device complete with aerator adaptor when used in conjunction with aerator system. Model CP 680-P by Hilti or approved alternative.
 - .2 Cast-in place firestop device for use with noncombustible penetrants. Model CP 680-M by Hilti or approved alternative.
 - .3 Speed sleeve for use with cable penetrations. Model CP 653 by Hilti or approved alternative.
 - .4 Firestop block. Model CFS-BL by Hilti or approved alternative.
- .4 Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating walls:
 - .1 Speed sleeve with integrated smoke seal fabric membrane. Model CP 653 by Hilti or approved alternative.
 - .2 Firestop Sleeve. Model CFS-SL SK by Hilti or approved alternative.
 - .3 Retrofit sleeve for use with existing cable bundles. Model CFS-SL RK by Hilti or approved alternative.

- .4 Gangplate for use with multiple cable management devices. Model CFS-SL GP by Hilti or approved alternative.
- .5 Gangplate Cap for use at blank openings in gangplate for future penetrations. Model CFS-SL GP CAP by Hilti or approved alternative.
- .5 Firestop insulation: to CAN/ULC S702, Type 2; mineral fibre manufactured from rock or slag, suitable for manual application.
 - .1 Density: Minimum 64 kg/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.
- .6 Damming, back-up, supports, and anchorage: In accordance with manufacturer's fire rated systems and to acceptance of authorities having jurisdiction.
- .7 Primer: As recommended by firestopping sealant manufacturer.

3 Execution

3.1 EXAMINATION

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

3.2 PREPARATION

- .1 Prepare, modify, and adjust void sizes, proportions, and conditions to conform to fire rated and smoke sealed assembly requirements such as assembly opening size and dimensional restrictions.
- .2 Clean surfaces to remove material detrimental to bond including dust, paint, rust, oil, grease, moisture, frost and other foreign matter to manufacturers recommendations.
- .3 Mask adjacent surfaces to avoid spillage and over-coating of adjacent surfaces. Remove stains from adjacent surfaces.

3.3 INSTALLATION

- .1 Install firestopping and smoke seal systems in accordance with reviewed Shop Drawings, manufacturer's instructions and fire rated assembly to establish continuity and integrity of fire separations.

- .2 Install firestop insulation in compacted thicknesses required by ULC design. Compress insulation approximately 50 percent.
- .3 Install primers as recommended by firestop and smoke seal Product manufacturers.
- .4 Install temporary forming, damming, back-up as required, remove after materials have achieved initial cure and will resist displacement.
- .5 Install firestop and smoke seal filler in horizontal joints providing 25% compression fit.
- .6 Use resilient, elastomeric firestopping and smoke seal systems in following locations:
 - .1 Openings and sleeves for future use.
 - .2 Penetration systems subject to vibration or thermal movement.
 - .3 Penetration systems in acoustical containment enclosures.
- .7 Trowel and tool exposed firestop and smoke seal. Product surfaces to uniform, smooth finish.
- .8 Seal joints to ensure an air and water resistant seal capable of withstanding compressions and extensions due to thermal wind or seismic joint movement.
- .9 Taped joints will not be acceptable.
- .10 Repair damaged firestopped and smoke sealed surfaces to acceptance of Consultant.
- .11 Identify each firestop and smoke seal penetration assembly with permanent label listing following:
 - .1 Assembly and rating in hours.
 - .2 Date of installation.
 - .3 Installing company's name and telephone number.
- .12 Do not cover materials until full cure has taken place.

3.4 **INSPECTION AND TESTING**

- .1 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E2174 to ensure that firestopping and smoke seals have been installed in accordance with Contract documents and to tested and listed firestop system.

3.5 **CLEAN-UP**

- .1 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.
- .2 Remove excess materials and debris immediately after application.

3.6 SCHEDULE OF FIRESTOP AND SMOKE SEAL LOCATIONS

- .1 Following firestop and smoke seal location schedule is included for convenience and may not be complete. Examine Contract Drawings and other specification sections and determine entire extent of work of this Section. Generally provide systems with required fire and smoke ratings at following locations:
- .1 Gaps at intersections of fire-resistance rated walls and partitions.
 - .2 Control and sway joints in fire-resistance rated walls and partitions.
 - .3 Gaps at top of fire-resistance rated partitions and walls.
 - .4 Penetrations through fire-resistance rated walls and partitions including but not limited to mechanical and electrical services and openings and sleeves for future use.
 - .5 Penetrations through fire-resistance rated floor slabs, ceilings, and roofs.
 - .6 Gaps at edge of floor slabs at exterior walls.
 - .7 Perimeter of retaining angles on rigid ducts greater than 0.012 m^2 , firestopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.
 - .8 Where indicated on drawings.
 - .9 At non-rated assemblies that require a smoke seal.
 - .10 Where required by Ontario Building Code.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for sealant work in accordance with the Contract Documents.
- .2 Work of this Section does not include sealants in firestopping and smoke sealed assemblies.
- .3 Work of this Section does not include sealant work identified in individual specification sections.

1.2 **REFERENCES**

- .1 ASTM C834, Specification for Latex Sealants.
- .2 ASTM C920, Specification for Elastomeric Joint Sealants.
- .3 ASTM C1330, Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.

1.3 **SUBMITTALS**

- .1 Product data: Submit copies of Product data in accordance with Section 01 33 00 describing type, composition and recommendations or directions for surface preparation, material preparation and material installation.
- .2 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00:
 - .1 Two samples of sealant/caulking, for colour selection.
 - .2 Two samples of back-up material and primer for physical characteristics.
- .3 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 **QUALITY ASSURANCE**

- .1 Qualifications: Work of this Section shall be executed by trained applicators approved by sealant manufacturer and having a minimum of 5 years proven experience.
- .2 Retain a Professional Engineer, licensed in Province of Ontario, with experience in scaffolding and rigging work of comparable complexity and scope, to perform following services as part of work of this Section:
 - .1 Design of scaffolding and rigging.
 - .2 Review, stamp, and sign shop drawings.

- .3 Conduct on-site inspections, prepare and submit written inspection reports verifying that this part of Work is in accordance with Contract Documents and reviewed shop drawings.

.3 Mock-up:

- .1 Construct one 1200 mm long mock-up of each sealant type in location acceptable to Consultant.
- .2 Demonstrate joint preparation, sealant application and tooling.
- .3 Arrange for Consultant's review and acceptance.
- .4 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
- .5 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

- .4 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.5 **SITE CONDITIONS**

- .1 Do not install materials when ambient air temperature is less than 5 °C, when recesses are wet or damp, or to manufacturer's recommendations.

1.6 **DELIVERY, STORAGE AND HANDLING**

- .1 Arrange delivery of materials in original, unopened packages with labels intact, including batch number, and ensure that on-site storage is kept to a minimum. Do not store materials on site where there exists any danger of damage from moisture, direct sunlight, freezing and other contaminants.

1.7 **EXTENDED WARRANTY**

- .1 Submit an extended warranty for Sealant work in accordance with General Conditions, except that warranty period is extended to 2 years from date of Ready-for-Takeover.
 - .1 Warrant against leakage, cracking, crumbling, melting, shrinkage, running, loss of adhesion and staining adjacent surfaces.
 - .2 Coverage: Complete replacement including affected adjacent work.

2 Products

2.1 **MATERIALS**

.1 General:

- .1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.

- .2 Use materials as received from manufacturers, without additives or adulterations. Use one manufacturer's Product for each kind of Product specified.
- .2 Sealant **Type A:** ASTM C920, Type S, Grade NS, Class 35; One-part, non-sag type, silicone sealant, in standard colours selected.
 - .1 'Dowsil CWS' by Dow Consumer Solutions.
 - .2 'Sikasil WS-305 CN' by Sika.
 - .3 'Tremsil 400' by Tremco.
- .3 Sealant **Type B:** ASTM C920, Type S, Grade NS; One-part mildew-resistant silicone, in standard colours selected.
 - .1 'Dowsil 786 Mildew Resistant Silicone Sealant' by Dow Consumer Solutions.
 - .2 'Sikasil GP Mildew Resistant' by Sika.
 - .3 'Tremsil 200 Silicone Sealant' by Tremco Ltd.
- .4 Sealant **Type C:** ASTM C920, Type M, Grade P, Class 25; Multi-component polyurethane-base, elastomeric sealant with self levelling properties, in standard colours selected.
 - .1 'Sikaflex 2c SL ' by Sika, or approved alternative.
- .5 Sealant **Type D:** ASTM C834.; Pure acrylic siliconized sealant; in standard white colour (paintable).
 - .1 '950A Siliconized Acrylic Latex Caulk' by Sherwin Williams.
 - .2 'Tremflex 834 Silconized Sealant' by Tremco Ltd.

2.2 ACCESSORIES

- .1 Primers: Type recommended by material manufacturers for various substrates, primers to prevent staining of adjacent surfaces encountered on project.
- .2 Joint backing: ASTM C1330; Round, solid section, closed cell, skinned surface, soft polyethylene foam gasket stock, compatible with primer and sealant materials, 30 to 50% oversized, Shore A hardness of 20, tensile strength 140 to 200 kPa. Bond breaker type surface.
- .3 Bond breaker: Type recommended by material manufacturers.
- .4 Void filler around the window frames to be one part expanding polyurethane foam.
- .5 Cleaning agents: As recommended by material manufacturer, non-staining, harmless to substrates and adjacent finished surfaces.

2.3 MIXING

- .1 Follow manufacturers instructions on mixing, shelf and pot life.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSPECTION**

- .1 Arrange for the manufacturer of sealant to have a qualified technical representative visit the Site prior to commencement of caulking to discuss with applicator and Consultant the procedures to be adopted, to analyse conditions under which work will be done and to inspect surfaces and joints to be sealed, in order that alternative recommendations may be made should adverse conditions exist.

3.3 **PREPARATION**

- .1 Erect scaffolding and rigging required to perform sealant work in accordance with reviewed Shop Drawings.
- .2 Protect adjacent exposed surfaces to prevent smearing, staining or other damage, by masking or other means, prior to performing work. Make good any damage caused by sealant application. Remove protection upon completion and clean adjacent, exposed surfaces of any compound deposited upon such surfaces.
- .3 Prepare joints to receive sealants to manufacturer's instructions. Ensure that joints are clean and dry and ferrous surfaces are free from rust and oil.
- .4 Clean recesses to receive sealant, to be free of dirt, dust, loose material, oil, grease, form release agents and other substances detrimental to sealant's performance.
 - .1 Remove lacquer or other protective coatings from metal surfaces, without damaging metal finish, using oil-free solvents. Remove rust, mill scale and coatings from ferrous metals by wire brush, grinding or sand blasting.
 - .2 Ensure recess is dry.
 - .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings. Remove incompatible coatings as required.
- .5 Ensure that all materials in contact with sealant are compatible. Test substrate for adhesion.
- .6 Depth of recess: Maintain depth to $\frac{1}{2}$ joint width up to a maximum of 13 mm and not less than 6 mm at centre of joint. For greater depth, use joint backing under. Where recess is less than specified depth, cut back surface of recess to specified recess depth.

- .7 Install polyethylene backing rod in joints 6 mm or more in width. Roll backing rod into joint. Do not stretch or bend backing rod. Install bond breaker to back of recess.
- .8 Prime sides of recess, in accordance with sealant manufacturer's instructions.
- .9 Prime all surfaces to ensure proper bond to tile, to eliminate potential staining of porous surfaces, and as required by sealant manufacturer.
- .10 Condition products for use in accordance with manufacturer's recommendations.

3.4 **INSTALLATION**

- .1 Apply sealant immediately after adjoining work is in condition to receive such work. Apply sealant in continuous bead using gun with correctly sized nozzle. Use sufficient pressure to evenly fill joint.
- .2 Ensure sealant has full uniform contact with, and adhesion to, side surfaces of recess. Superficial painting with skin bead is not acceptable. Tool sealant to smooth surface, free from ridges, wrinkles, sags, air pockets, embedded impurities, dirt, stains or other defects.
 - .1 At recesses in angular surfaces, finish sealant with flat profile, flush with face of material at each side.
 - .2 At recesses in flush surfaces, finish compound with concave face, flush with face of material at each side.
- .3 Make sealant bead uniform in colour.
- .4 Cure sealants in accordance with sealant manufacturer's instructions. Do not cover up sealants until proper curing has taken place.
- .5 Immediately remove excess compound or droppings which would set up or become difficult to remove from adjacent finished surfaces, using recommended cleaners, as work progresses. Do not use scrapers, chemicals or other tools which could damage finished surfaces. Remove defective sealant.
- .6 Clean recesses and re-apply sealant.
- .7 Remove masking tape immediately after joints have been sealed and tooled.

3.5 **CLEANING**

- .1 Clean surfaces adjacent to joints, remove sealant smears or other soiling resulting from application of sealants. At metal surfaces, remove residue. Do not mar or damage finishes on materials adjacent to joints. Repair or replace marred or damaged materials.

3.6 **SCHEDULE OF LOCATIONS**

- .1 Following sealant location schedule is included for convenience and may not be complete. Examine Contract Drawings and other specification sections and determine entire extent of work of this Section. Generally seal following locations:
 - .1 Concrete, masonry, wood and stone to metal.
 - .2 Wood to masonry, concrete and stone.
 - .3 Metal to metal.
 - .4 All dissimilar materials.
 - .5 Where 'sealant' or 'caulking' is indicated on drawings.

- .2 Sealant **Type A:**
 - .1 Exterior joints between masonry and steel or aluminum.
 - .2 Exterior joints between masonry and shelf angle.
 - .3 Exterior joints between steel or aluminum and concrete or masonry.
 - .4 Interior and exterior control joints, except in floors .
 - .5 Door frames, louvre frames, interior and exterior side.
 - .6 Protrusions through interior and exterior walls and floors, interior and exterior side, except where fire rated seals are required.
 - .7 Seal thresholds.

- .3 Sealant **Type B:**
 - .1 Control joints in vertical tiled areas.
 - .2 Between vanity and tile.
 - .3 Between vanity and mechanical fixtures/ittings.
 - .4 Between access panels and tile.
 - .5 Between tiles and adjacent materials.

- .4 Sealant **Type C:**
 - .1 Control joints in horizontal tiled areas.

- .5 Sealant **Type D:**
 - .1 Perimeter of kitchen counters.
 - .2 Perimeter of interior windows.
 - .3 Perimeter of firehose cabinets.
 - .4 Junction between drywall and masonry.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for expansion joint cover assemblies work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM B221M, Specification for Aluminum-Alloy Extruded Bars, Rods, Wires, Shapes and Tubes.

1.3 **DESIGN REQUIREMENTS**

- .1 Joint Movement: Design to permit unrestricted omnidirectional movement of up to $\pm 50\%$ of joint width without disengagement of cover.
- .2 Joint Cover Movement: Design exterior joint cover assemblies to accommodate expansion and contraction within service temperature range of -35°C to 65°C .

1.4 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00.
 - .2 Submit following for each type of cover assembly and joint condition:
 - .1 Elevations, sections, lengths, details, materials, dimensions, gauges, anchoring and fasteners, accessories, seals, finishes and relationship to adjacent construction.
- .3 Samples: Submit two 300 mm long sample of each cover assembly in accordance with Section 01 33 00.

1.5 **QUALITY ASSURANCE**

- .1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of expansion joint cover assemblies of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.

- .2 Mock-up:
 - .1 Construct one mock-up of each different type of expansion joint cover assemblies in location acceptable to Consultant.
 - .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
 - .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
 - .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

2 Products

2.1 **MATERIALS**

- .1 General: All materials under work of this Section, including but not limited to, adhesives are to have low VOC content limits.
- .2 Aluminum extrusions: ASTM B221, AA6063 alloy, T5 temper.

2.2 **ACCESSORIES**

- .1 Firebarrier: Floor and wall joints shall be complete with fire barrier and fire-rated for 2 hours and UL or Warnock Hersey listed designs. Extend fire barrier beyond expansion joint cover, in concealed locations to maintain fire rating, for full length of expansion joint.
- .2 Spring Clips: Stainless steel to manufacturer's standard.
- .3 Concealed fasteners and anchors to manufacturer's standard.
- .4 Filler strip adhesive to manufacturer's standard.

2.3 **FABRICATION**

- .1 Verify dimensions of existing work before commencing fabrications and report discrepancies to Consultant.
- .2 Fabricate work in accordance with reviewed shop drawings.
- .3 Fabricate expansion joint covers, square, true, straight and accurate to required sizes and profiles.
- .4 Fabricate lengths in continuous runs up to 6000 mm.
- .5 Shop assemble covers ready for installation where practicable.
- .6 Fabricate floor joint cover assemblies with anchors, levelling nuts, filler inserts etc. as required for a complete installation to suit installation and project requirements.

- .7 Fabricate work free from defects impairing function, appearance, strength and durability.

2.4 FINISHES

- .1 Aluminum:
 - .1 Hidden components: Mill finish, AA-M10 designation.
 - .2 Exposed components: Clear anodized, Class II, AAM12C22A31.
 - .3 In contact with concrete: Prime painted.

3 Execution

3.1 EXAMINATION

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

3.2 PREPARATION

- .1 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance.
- .2 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.

3.3 INSTALLATION

- .1 Install expansion joint cover assemblies in accordance with reviewed shop drawings and manufacturer's written instructions.
- .2 Set work plumb, square, level, free from distortion.
- .3 Secure work accurately to structure in manner not restricting joint movement.
- .4 Provide acceptable means of anchorage, such as anchor clips, expansion bolts and shields, welded studs or toggles.
- .5 Seal butt joints to manufacturer's instructions to provide watertight and lighttight joints.
- .6 Adjust joint cover to freely accommodate joint movement.
- .7 Install corner bead sealant in accordance with Section 07 92 00.

3.4 **SCHEDULE**

- .1 Interior floor to wall and floor to floor joint: Extruded aluminum frame and cover plate, for use at 50 mm wide joint, all aluminum in contact with concrete to have zinc chromate finish and mill finish on exposed; 'Model GFTW-100/50' with fire barrier by C/S Construction Specialties Ltd. or approved alternative by MM Systems. Gasket colour to be selected by Consultant
- .2 Interior floor to floor joint: Extruded aluminum frame, with thermoplastic gasket, capable of approximately 25% movement, all aluminum in contact with concrete to have zinc chromate finish and mill finish on exposed; 'Type GFT series' by C/S Construction Specialties Ltd. or approved alternative by MM Systems.
- .3 Interior gypsum board wall joint: Extruded aluminum frame and dual durometer TPR gasket, for use at 50 mm wide joint; 'Model FWF-200' by C/S Construction Specialties Ltd. or approved alternative by MM Systems. Colour: To be selected by Consultant.
- .4 Interior ceiling/ceiling joint: Extruded aluminum frame and cover plate, capable of approximately 50% movement, all aluminum in contact with concrete to have zinc chromate finish and mill finish on exposed; 'FCS-200' by C/S Construction Specialties Ltd or approved alternative.
- .5 Interior ceiling/wall joint: Extruded aluminum frame and cover plate, capable of approximately 50% movement, all aluminum in contact with concrete to have zinc chromate finish and mill finish on exposed; 'FCSC-200' by C/S Construction Specialties Ltd or approved alternative.
- .6 Exterior vertical joint (brick veneer): Pre-formed, impregnated compressible foam block, UV stable, flexible, non-rotting system, 51 mm joint size, in colours selected by Consultant. 'VF Series' by C/S Construction Specialties Ltd. or approved alternative.
- .7 Wall joint: Extruded aluminum frame and cover plate, with 2 hour fire-rating, capable for use of 25 mm to 150 mm wide joint, all aluminum in contact with concrete to have zinc chromate finish and mill finish on exposed; 'Model FB-24' with fire barrier by C/S Construction Specialties Ltd. or approved alternative by MM Systems. Gasket colour to be selected by Consultant

- .8 Expansion joint locations horizontal and vertical application as required:
 - .1 2 hour fire-rated, watertight and sound attenuating, preformed expanding foam sealant consisting of two water-repellant silicone sealing surfaces adhered to fire-retardant impregnated foam backing, installed with tensionless bellows and silicone sealant beads for a watertight seal. Colour to be selected by Consultant from manufacturer's standard range.
 - .2 Provide silicone and intumescent sealants as required for fire rating and watertight requirement of preformed expanding foam sealant.
 - .3 Acceptable manufacturers: 'Emshield WFR2' by Emseal or approved alternative.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for metal door and frame work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .2 ASTM A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- .3 CAN4/ULC-S104M, Standard Method for Fire Test of Door Assemblies.
- .4 CAN4/ULC-S105M, Standard Specification for Fire Door Frames, Meeting the Performance Required by CAN4/ULC-S104M.
- .5 CAN/CGSB-1.198, Cementitious Primer, (for Galvanized Surfaces).
- .6 CGSB 41-GP-19Ma, Rigid Vinyl Extrusions for Windows and Doors.
- .7 CAN/ULC-S702, Thermal Insulation, Mineral Fibre for Buildings.
- .8 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
- .9 CSA W59-M, Welded Steel Construction (Metal Arc Welding).
- .10 CSDMA, Canadian Steel Door Manufacturers Association.
- .11 NFPA 80, Standard for Fire Doors and Other Opening Protectives.
- .12 NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

1.3 **DESIGN REQUIREMENTS**

- .1 Design exterior frame assemblies to accommodate expansion and contraction when subjected to minimum and maximum surface temperature of -35°C to 35°C.
- .2 Maximum deflection for exterior metal doors under wind load of 1.2 kPa not to exceed 1/175th of span.

1.4 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating door and frame construction.

- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 for each type of door and frame indicating:
 - .1 Thickness and type of steel.
 - .2 Thickness and type of core.
 - .3 Thickness and type of steel stiffeners and location of them within the door.
 - .4 Thickness and type of metal facing on edges of door and method of fastening.
 - .5 Location of mortises, reinforcement, anchorages, joining, welding, sleeving, exposed fasteners, openings and arrangement for hardware.
 - .2 Include schedule identifying each unit with door marks and numbers relating to numbering on Contract Drawings and in door schedule. Indicate doors and frames to be fire rated.

1.5 **QUALITY ASSURANCE**

- .1 Perform work in accordance with requirements of the Canadian Steel Door Manufacturer's Association (CSDMA).
- .2 Label and list fire rated doors and frames by an organization acceptable to authorities having jurisdiction and accredited by the Standards Council of Canada in conformance with CAN4/ULC-S104M and CAN4/ULC-S105M for ratings indicated, Labelling shall be in accordance with NFPA 80.

2 **Products**

2.1 **ACCEPTABLE MANUFACTURERS**

- .1 Hollow metal doors and frames:
 - .1 Daybar Industries Limited
 - .2 Fleming Doors Products.
 - .3 Steelcraft.
 - .4 Vision Hollow Metal Limited.
 - .5 Or approved alternative.
- .2 Prefinished steel frames: Dunbarton or approved alternative.

2.2 **MATERIALS**

- .1 General: All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.
- .2 Steel: ASTM A924/A924M, Class 1; Commercial grade steel, hot dip galvanized to ASTM A653/A653M, ZF120 galvanized coating.

- .3 Minimum base steel thickness:
 - .1 Frames 1.6 mm
 - .2 Typical doors 1.6 mm
 - .3 Interior stiffeners 0.9 mm
 - .4 Lock/strike reinforcements 1.6 mm
 - .5 Hinge reinforcements 2.7 mm
 - .6 All other reinforcement 1.6 mm
 - .7 Top and bottom channels 1.2 mm
 - .8 Glazing stops 0.9 mm
 - .9 Guard boxes 0.9 mm
 - .10 Jamb spreaders 0.9 mm
- .4 Top caps and thermal breaks: CGSB 41-GP-19Ma; Rigid PVC extrusions.
- .5 Primer: CAN/CGSB 1.198.
- .6 Core material:
 - .1 Interior doors: Mineral fibre insulation with a minimum face density of 24 kg/m³ (1.5 lbs/ft³).
 - .2 Exterior doors: Rigid poly/isocyanurate, closed cell insulation, 32 kg/m³ (2.0 lbs/ft³), thermal value: RSI 1.9.
 - .3 Fire rated doors: Mineral fibre insulation to CAN/ULC S702, Type 1A; 24 kg/m³ (1.5 lbs/ft³).
- .7 Screws: Stainless steel screws with countersunk flat head.
- .8 Door silencers: Type 6-180, black neoprene.
- .9 Frame anchors:
 - .1 Frames in masonry: 1.2 mm minimum, adjustable T-strap jamb anchors.
 - .2 Frames in steel stud partitions: 0.9 mm minimum steel anchors of suitable design securely welded inside each jamb.
 - .3 Labeled frames: In accordance with ULC requirements.
- .10 Floor anchors: 1.6 mm minimum adjustable floor clip angles with 2 holes for anchorage to floor.
- .11 Labels for fire doors and door frame: Brass plate, riveted to door and door frame.
- .12 Grilles: Corrosion resistant steel with baked enamel finish. Model 61DG Series by Nailor Industries Inc or approved alternative by Hart and Cooley.
- .13 Glass and glazing: In accordance with Section 08 80 00.

2.3 FABRICATION

- .1 General
 - .1 Fabricate doors and frames in accordance with reviewed shop drawings.
 - .2 Welding: CSA W59-M to produce a finished unit with no visible seams or joints, square, true and free of distortion.

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- .3 Welding: Continuous unless specified otherwise. Execute welding by a firm fully acceptable to the Canadian Welding Bureau to requirements of CSA W47.1.
 - .4 Form profiles accurately to details shown on Contract Drawings.
 - .5 Ream and remove burrs from drilled and punched holes.
 - .6 Grind welded corners and joints to a flat plane and fill with metallic filler and sand to a uniform smooth finish. Apply one coat of primer.
 - .7 Provide weather strip for exterior doors in accordance with Section 08 70 00 and door manufacturer.
- .2 Frames, windows, and screens:
- .1 Fabricate frames of welded construction. Cut mitres and joints accurately and weld continuously on inside of frame profile. Exterior frames to be thermally broken.
 - .2 Construct large frame sections with provision for on Site assembly to suit Site conditions.
 - .3 Blank, reinforce, drill and tap frames for mortised, templated hardware. Protect mortised cut-outs with guard boxes.
 - .4 Reinforce frames where required for surface mounted hardware.
 - .5 Reinforce frames over 1200 mm wide with roll formed steel channels or hollow structural sections specified in Section 05 50 00 and as indicated on drawings.
 - .6 Furnish exterior door frames with a continuously welded integral steel weather drip at head of frame.
 - .7 Prepare each door opening for single stud rubber door silencers, 3 for single door openings located in strike jamb, and 2 for double door openings located in head.
 - .8 Install 2 channel or angle spreaders per frame, to ensure correct frame alignment. Install stiffener plates or spreaders between frame trim where required, to prevent bending of trim and to maintain alignment when setting in place.
 - .9 Form channel glazing stops minimum 16 mm height, accurately cut, mitred, fitted and fastened to frame sections with stainless steel counter-sunk, flat head screws spaced at maximum 450 mm throughout and 50 mm from each end.
 - .10 Provide the following requirements for electrified frame applications:
 - .1 Low voltage wire conduit for required electrified hardware devices.
 - .2 Junction boxes for all frame mounted electrified hardware devices, complete with required connectors to in frame low voltage wire conduit.
- .3 Anchorage:
- .1 Anchor units to floor and wall construction. Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb, minimum number of anchors for each jamb:
 - .1 Frames up to 2285 mm 3 anchors.
 - .2 Frames from 2285 mm to 2440 mm 4 anchors.
 - .2 Where frames are to be set in masonry or concrete, supply adjustable anchors to trade installing frame.

- .3 Fabricate frames for installation in steel stud partitions with steel anchors of suitable design, minimum number of anchors for each jamb :
 - .1 Frames up to 2285 mm height 4 anchors.
 - .2 Frames 2285 mm to 2440 mm 5 anchors.
- .4 General Door Requirements:
 - .1 Hollow steel construction, flush swing type, of sizes to conform to details, schedules and reviewed shop drawings with provisions for cut-outs for glass and grilles and reinforced to receive hardware fastenings.
 - .2 Blank, reinforce, drill and tap doors for mortised, templated hardware. Where required, reinforce doors for surface mounted hardware and door closers.
 - .3 Reinforce oversized doors with steel channels and plates specified in Section 05 50 00 and as indicated on drawings.
 - .4 Where openings are required, form integral cut-outs with framing, glass stop moldings and division bars.
 - .5 Install grilles to fit tight and secure into openings.
 - .6 Bevel both stiles of single doors 1 in 16.
 - .7 Reinforce doors with galvanized metal stiffeners at 150 mm o.c.
 - .8 Provide the following requirements for electrified door applications:
 - .1 In door low voltage wire raceways.
 - .2 Steel astragals for hollow metal doors.
 - .3 Reinforcement for all door mounted electrified hardware devices as required and as indicated on Contract Drawings.
- .5 Interior Doors:
 - .1 Supply and install inverted, recessed, fully welded channels at top and bottom of doors.
 - .2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints continuously welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure that no filler is used in joints.
 - .3 Fill hollow space within door and vertical stiffeners from top to bottom with mineral fibre batt insulation.
- .6 Exterior Doors:
 - .1 Supply and install inverted, recessed, fully welded channels at top and bottom of doors. Supply and install PVC top caps.
 - .2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints continuously welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure that no filler is used in joints.
 - .3 Fill hollow space within door from top to bottom with rigid polyisocyanurate insulation.
- .7 Fire Rated Doors:
 - .1 Supply and install inverted, recessed, spot welded channels at top and bottom of doors. Supply and install steel flush top caps on exterior doors.
 - .2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints continuously welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure that no filler is used in joints.

- .3 Fabricate doors to achieve fire rating as indicated on drawings and in accordance with ULC. Provide ULC label plate on door at hinged edge midway between top hinge and head of door.

3 Execution

3.1 **EXAMINATION**

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

3.2 **HOLLOW METAL DOOR, FRAME, WINDOW AND SCREEN INSTALLATION**

- .1 Install hollow metal doors, frames, windows, and screens in accordance with reviewed shop drawings, manufacturer's written instructions and to meet CSDMA requirements.
- .2 Install hollow metal doors, frames, windows, and screens plumb, square, level, secure, and at correct elevation.
- .3 Install doors clear of floor finishes, and with the correct rebate opening for the door installation. Install door silencers.
- .4 Secure anchorages and connections to adjacent construction. Brace frames rigidly in position while building-in. Remove temporary steel shipping jamb spreaders. Install wood spreaders at third points of frame rebate height to maintain frame width. Supply and install vertical supports as indicated on drawings for openings over 1200 mm in width. Remove wood spreaders after frames have been built-in.
- .5 Allow for structural deflection and prevent structural loads from being transmitted to hollow metal frames.
- .6 Touch-up areas where galvanized coating has been removed or damaged with primer.
- .7 Fire rated doors: Install fire rated doors and frames in accordance with requirements of NFPA 80.

3.3 **ADJUSTING AND CLEANING**

- .1 Adjust doors for smooth and balanced door movement.
- .2 Clean doors, frames, windows and screens.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for the wood doors work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ANSI A208.1, Particleboard.
- .2 ASTM D198, Standard Test Methods of Static Tests of Lumber in Structural Sizes.
- .3 ASTM D1037, Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
- .4 CSA O112 Series, Wood Adhesives.
- .5 CAN4 S104-M, Standard Method for Fire Tests of Door Assemblies.
- .6 CAN4 S105-M, Fire Door Frames.
- .7 CAN/CGSB 11.3-M, Hardboard.
- .8 North American Architectural Woodwork Standards (NAAWS).
- .9 NFPA 80, Standard for Fire Doors and Other Opening Protectives.

1.3 **SUBMITTALS**

- .1 Shop drawings: Submit shop drawings of wood doors in accordance with Section 01 33 00 indicating detail thicknesses, core construction, veneers, finish, door sizes, quantities, fastenings and finishes.
- .2 Samples: Submit two minimum 300 x 300 mm door samples for each type of finish and cut-a-way corners showing construction and materials in accordance with Section 01 33 00.

1.4 **QUALITY ASSURANCE**

- .1 Perform Work in accordance with requirements of AWMAC, Quality Standards for Architectural Woodwork, Premium Grade, except as indicated otherwise.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver, store, and handle wood doors in accordance with the AWMAC Quality Standards amended as follows:
 - .1 Wrap wood doors individually in protective wrapping for shipment and Site storage.
 - .2 Handle wood doors carefully to prevent damage; replace damaged doors.

- .3 Store doors flat on a dry, level surface. Ventilate and maintain recommended relative humidity before, during and after installation.

1.6 EXTENDED WARRANTY

- .1 Submit an extended warranty for wood door Work in accordance with General Conditions, except that warranty period is extended to 2 years for doors in suites, 3 years for suite entry door Work by manufacturer and 2 years for suite entry door Work by Installation Contractor from date of Substantial Completion.
 - .1 Warrant against warpage, delamination, sag and other defects. Warranty shall include hanging, finishing and complete replacement cost of defective doors.
 - .2 Coverage: Complete replacement including affected adjacent Work.

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 Certified wood.
 - .2 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.
- .2 Wood doors (solid core):
 - .1 5 ply wood door: As manufactured by Baillargeon Doors Inc. or Lambton Doors.
 - .2 Core: To ANSI A208.1, minimum density 513 kg/m³ minimum, sanded faces, of thickness to fill void. Extruded particle board cores with voids are not permitted.
 - .3 Rails:
 - .1 Top: 35 mm structural composite lumber.
 - .2 Bottom: 35 mm structural composite lumber.
 - .4 Stiles
 - .1 16 mm hardwood laminated to 19 mm structural composite lumber.
 - .2 Edge detail: NAAWS, Type A.
 - .5 Crossbanding: Minimum 2.2 mm thick minimum wood based composite.
 - .6 Door facing: Minimum 0.8 mm, white oak grade Veneer finished in accordance with Section 09 91 00.
- .3 Wood doors (fire rated):
 - .1 'Fire Door Series' by Baillargeon Doors Inc. or 'Fire Door' by Lambton Doors.
 - .2 Core: Fire rated mineral core. Density of 28-32 lbs per cubic foot.
 - .3 Internal blocking: NAAWS Option #3; Manufacturers' standard fire resistant blocking.

- .4 Top and Bottom Rails: 85 mm laminated strand lumber bonded with type 1 water-resistant adhesive as per ASTM-D1037 and ASTM-D198, 30 mm low-density wood or laminated strand lumber.
 - .5 Stiles: 107 mm including 85 mm laminated strand lumber bonded with type 1 water-resistant adhesive as per ASTM-D1037 and ASTM-D198, 30 mm wood.
 - .6 Crossbanding: Minimum 2.2 mm thick HDF composite.
 - .7 Door facing: Minimum 0.8 mm, white oak grade Veneer finished in accordance with Section 09 91 00.
- .4 Wood doors (hollow core):
- .1 5 ply hollow core doors as manufactured by Baillargeon Doors Inc. or Lambton Doors.
 - .2 Rails:
 - .1 Top: 38 mm hardwood.
 - .2 Bottom: 38 mm hardwood.
 - .3 Stiles
 - .1 Hinge: 38 mm hardwood edge strip.
 - .2 Lock: 38 mm hardwood edge strip.
 - .3 Perimeter of glazing: 38 mm hardwood.
 - .4 Edge detail: NAAWS, Type A.
 - .4 Crossbanding: Minimum 2.2 mm thick HDF composite.
 - .5 Door facing: Minimum 0.8 mm paint grade Veneer finished in accordance with Section 09 91 00.
- .5 Edge finish: To match door facings.
- .6 Adhesive: CSA O112 Series, Type I; Waterproof.
- .7 Sliding door hardware: Top hung, aluminum track and components, sliding hardware system consisting of, but not limited to the following components: extruded aluminum upper track, double roller running gear, track stopper, suspension plate and floor mounted guide; 'Hawa Media 70' by Hafele or approved alternative.
- .8 Door frames:
- .1 Wood door frames in accordance with Section 06 20 00.
 - .2 Metal door frames in accordance with Section 08 11 13.
- .9 Glazing: In accordance with Section 08 88 00.

2.2 **FABRICATION**

- .1 Fabricate doors to sizes indicated on drawings.
- .2 Fabricate doors square, true, and free from distortion waves, ridges or core ghost lines. Factory machine doors for finish hardware and flooring.
- .3 Fabricate doors using hot press construction technology. Bond stiles and rails to core using adhesive. Sand for uniform thickness. Laminate door facing and trim, to assembled core in hot press.

- .4 Cut and bevel stile edges as follows:
 - .1 Lock side: 3 mm in 50 mm.
 - .2 Hinge side: 1.5 mm in 50 mm.
- .5 Finish wood doors in factory and deliver to site ready for hanging.

2.3 **FIRE RATED DOORS**

- .1 Fabricate and label fire rated wood doors with plate label indicating fire protection rating as indicated on door schedule.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Install doors plumb, rigid, square, clear of floor finishes, and with correct rebate opening for door installation.
- .2 Conform to requirements of AWMAC Quality Standard, for wood door installation.
- .3 Automatic door operators to be supplied and installed by Section 08 71 13. Install doors and hardware to manufacturers' written instructions. Clean and adjust hardware for correct performance.

3.3 **FIRE RATED DOORS**

- .1 Install fire rated doors in accordance with the requirements of ULC and NFPA 80.

3.4 **ADJUSTING AND CLEANING**

- .1 Replace the following wood doors:
 - .1 Warped more than 3 mm, measured at any point on door, relative to perfectly flat surface.
 - .2 Core telegraphing visible at 1500 mm distance, under final Site lighting conditions.
- .2 Adjust doors for smooth and balanced door movement.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, tool, equipment and services necessary for Aluminum work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 AAMA 501, Methods of Test for Exterior Walls.
- .2 AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels - Series: Components, Coatings and Finishes.
- .3 AAMA CW-10, Care and Handling of Architectural Aluminum from Shop to Site.
- .4 AAMA CW-DG-1, Aluminum Curtain Wall Design Guide Manual.
- .5 AAMA/WDMA/CSA 101/I.S.2/A440, Standard Specification for Windows, Doors, and Unit Skylights.
- .6 ANSI H35.1M, Alloy and Temper Designation Systems for Aluminum (Metric).
- .7 ASTM A167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
- .8 ASTM B209M, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .9 ASTM B221M, Specification for Aluminum-Alloy Extruded Bars, Rods, Wires, Profiles and Tubes.
- .10 ASTM C920, Specification for Elastomeric Joint Sealants.
- .11 ASTM E283, Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- .12 ASTM E330, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- .13 ASTM E331, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
- .14 ASTM F738M, Specification for Stainless Steel Metric Bolts, Screws, and Studs.
- .15 CAN/CGSB 1.108-M, Bituminous Solvent Type Paint.
- .16 CAN/ULC S702, Thermal Insulation, Mineral Fibre, for Buildings.

- .17 CAN/ULC S705.1, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density - Material Third Edition.
- .18 NFRC 100, Procedure for Determining Fenestration Product U-factors.
- .19 NFRC 200, Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.

1.3 **DEFINITION(S)**

- .1 Aluminum work: Shall mean aluminum curtainwall, entrances, louvres, vestibules, doors, and framing mentioned in Part 2 of this Specification Section.

1.4 **DESIGN REQUIREMENTS**

- .1 Design Aluminum work to meet requirements of AAMA/WDMA/CSA 101/I.S.2/A440, AAMA CW-DG-1, ASTM E283, ASTM E330, ASTM E331, NFRC 100, NFRC 200 and to meet performance and energy requirements specified herein and as required by authorities having jurisdiction.
- .2 Design Aluminum work in accordance with following Climatic Design Data for Toronto contained in the Ontario Building Code:
 - .1 Design temperature: January 1%, July 2 1/2% .
 - .2 Hourly wind pressures: 1 in 50 year occurrence.
 - .3 Seismic design: Class "C".
- .3 Design complete aluminum window systems, including glazing, to meet the following performance criteria:
 - .1 U-factor: To Follow.
 - .2 SHGC: To Follow.
- .4 Design complete aluminum entrance door systems, including glazing, to meet the following performance criteria:
 - .1 U-factor: To Follow.
 - .2 SHGC: To Follow.
- .5 Design Aluminum work to accommodate following without producing detrimental effect:
 - .1 Cyclic 40°C daily thermal swing of components.
 - .2 Cyclic, dynamic loading and release of loads such as wind loads.
 - .3 13 mm vertical deflection in supporting structure and movement of supporting structure due to live, dead load, and creep or deflections, seismic load, sway displacement and similar items.
- .6 Design to prevent accumulation of condensate on interior side of Aluminum work framing under the following service conditions:
 - .1 Interior summer temperature: 21°C.
 - .2 Interior winter temperature: 21°C.
 - .3 Exterior temperature: -20°C.

- .4 Interior RH: 35%.
- .7 Design windows in accordance to AAMA/WDMA/CSA -101/I.S.2/ A440, to the following performance levels:
 - .1 Performance class: CW.
 - .2 Minimum performance grade (PG): 30.
 - .3 Minimum positive design pressure: 1440 Pa.
 - .4 Minimum negative design pressure: - 1440 Pa.
 - .5 Minimum water penetration test pressure: 220 Pa.
 - .6 Minimum air infiltration/exfiltration: A2.
 - .7 Condensation resistance: I57
- .8 Restrict air infiltration/exfiltration, through Aluminum work in accordance with ASTM E283 at pressure differential as indicated:
 - .1 Curtainwalls and entrance assemblies: $0.0003 \text{ m}^3/\text{s m}^2$ at differential of 300 Pa.
 - .2 Doors (per door): $2.78 \text{ m}^3/\text{h m}$ per linear metre of crack at differential of 75 Pa.
- .9 Design and detail controlled drainage path to actively discharge water, which enters into or forms within Aluminum work, to exterior; prevent accumulation or storage of water within Aluminum work. Prevent water from entering interior when tested in accordance with ASTM E331 at a pressure differential of 700 Pa.
- .10 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.
- .11 Prevent deflection and permanent or progressive glazing displacement. Restrict horizontal and vertical mullion deflection to less than $L/175$ and 19 mm maximum for heights under 4115 mm and $L/240$ and 25 mm maximum for heights over 4115 mm.
- .12 When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span in accordance with ASTM E330.
- .13 Design anchorage inserts for installation as part of other Sections of work. Design anchorage assemblies to accommodate construction and installation tolerances.
- .14 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.

- .15 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.
- .16 Design curtain wall system to incorporate 25 mm architectural louvres as indicated on drawings.

1.5 SUBMITTALS

- .1 Shop drawings:
 - .1 Submit shop drawings for mock-ups and Aluminum Work in accordance with Section 01 33 00 indicating:
 - .1 Plans, sections, details, type of extrusions, profiles, finishes, panels, spandrels, operating components, doors, related flashings, closures, fillers, and end caps, and sealants.
 - .2 Products and glazing types.
 - .3 Calculations or modelling confirming Aluminum work conforms to specified performance and energy requirements.
 - .4 Structural integrity of Aluminum work, anchorage inserts, and system installation tolerances.
 - .5 Section and hardware reinforcement, anchorage, assembly fixings.
 - .6 Detailing, locations, and allowances for movement, expansion, contraction
 - .7 Air barrier and vapour retarder continuity and path of cavity drainage and air pressure equalization.
- .2 Samples:
 - .1 Submit two samples of following in accordance with Section 01 33 00;
 - .1 250 mm long samples of each type of extrusion and finish.
 - .2 250 x 200 mm samples of insulating glass unit.
 - .3 One complete corner detail of door frame, glazing, wood slats within curtain wall and finish for each door type.
 - .4 Each door hardware item for Consultant's approval.
 - .5 250 x 200 mm sample of aluminum panel.
- .3 Reports:
 - .1 Submit substantiating engineering data, and independent test results of pre-tested, Aluminum work to substantiate compliance with the design criteria including air leakage and water penetration conforming to ASTM E283 and ASTM E331.
 - .2 Engineering data demonstrating compliance with test procedures outlined in AAMA 501 including as a minimum air leakage resistance, static pressure water penetration resistance, dynamic pressure water penetration resistance, wind load resistance, vertical live load deflection movement and lateral (horizontal) movement, and condensation resistance.

- .3 Submit documentation to substantiate ten years of experience in Aluminum work manufacture and installation of similar size and nature.
- .4 Close-out submittals: Submit Aluminum work data for incorporation into the Operations and Maintenance Manual as part of Section 01 78 00.
- .5 Extended warranties: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.6 **QUALITY ASSURANCE**

- .1 Retain a Professional Engineer, licensed in Province of Ontario, with experience in Aluminum work of comparable complexity and scope to perform the following services as part of the work of this Section:
 - .1 Design of Aluminum work.
 - .2 Review, stamp, and sign shop drawings.
 - .3 Conduct on-Site inspections and prepare and submit inspection reports. Number and frequency of inspection to be sufficient to satisfy Engineer that Work is being fabricated and installed in accordance with reviewed shop drawings and design intent.
- .2 Shop mock-up:
 - .1 Provide one, full scale mock-up in shop of Aluminum work for shop testing, including air leakage, water penetration, and deflection in accordance with AAMA/WDMA/CSA 101/I.S.2/A440, AAMA 501, ASTM E283, ASTM E330, and ASTM E331. If a test fails, additional testing may be required by Consultant to ensure performance of Aluminum Work at no additional cost to Owner.
 - .2 Demonstrate conformance to specified design requirements.
 - .3 Mock-up shall show full range of Products, finishes, textures, quality of fabrication, and workmanship including, but not limited to, framing members, glazing units, anchorage, opening units, doors and transitions to adjoining assemblies and materials.
- .3 Pre-installation meetings:
 - .1 Mock-ups: Prior to installation of mock-ups, arrange meeting at the shop and on Site to be attended by Consultant, Contractor, and Engineer and site superintendent to inspect substrates, and to review installation procedures 48 hours in advance of installation.
 - .2 Site: Prior to installation of curtain wall, arrange meeting at the Site to be attended by Consultant, Contractor, and Engineer and site superintendent to inspect substrates, and to review installation procedures 2 weeks in advance of installation.

1.7 **DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver, store, and handle Aluminum Work in accordance with AAMA CW-10 and manufacturer's written recommendations.

- .2 Protect aluminum surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Do not remove before final cleaning of building.

1.8 **EXTENDED WARRANTY**

- .1 Aluminum work: Submit an extended warranty for Aluminum work in accordance with General Conditions, except that warranty period is extended to 5 years.
 - .1 Warrant against failure to meet the design criteria and requirements such as interior leakage, and frame condensation.
 - .2 Coverage: Labour and materials to repair or replace Aluminum Work as required to correct deficient work and meet specified requirements including affected adjacent work.
- .2 Glazing:
 - .1 Provide a 10 year warranty, commencing from date of Substantial Performance, against defects in the insulating glass units and warrant them to be free from material obstruction of vision as a result of dust or film formation on the internal glass surfaces by any cause, under normal design conditions. Warrant the following:
 - .1 The insulating glass units shall be free from condensation, fogging material obstruction of vision as a result of dust or film formation on the internal glass surfaces by any cause under design conditions.
 - .2 The insulating glass units shall not change their mechanical design properties and shall not in any way deteriorate, degrade, delaminate or change their visual appearance.
 - .3 The glass units will not break due to thermal shock and temperature differential due to inherent glass faults, other than extrinsic glass breakage.
 - .4 Internal fogging shall be deemed to occur when light transmission of the glass is reduced by 5% in any 50 mm x 50 mm area.
 - .5 Failure will be deemed to occur when the internal dew point exceeds -40oC in a 21oC ambient temperature (when tested in accordance with ASTM E576).
 - .2 Warrant that glazing work is water and weather tight and free from distortion; that glazing materials will not deteriorate from exposure to the atmosphere and weather, will not be displaced, and will be free from permanent deformation under load; and that glass and insulating glass units will not be broken, cracked or scratched by causes resulting from defects in material, workmanship or design of glazing installation.
 - .3 Cracked or scratched glass, shrinking, cracking, staining, hardening, sagging of glazing materials; loosening or rattling of glass; and leaking of glazed joints will be considered defective work.
 - .4 Warranty shall provide for the removal of defective Products, replacement with new Products conforming to the specifications, and restoration of work damaged by removal and replacement including labour and installation costs.

3. Manufacturer's finish Warranty: Provide manufacturer's written warranty naming Owner as beneficiary and covering finish degradation or failure of factory-applied exterior fluoropolymer finish on Aluminum work within the warranty period; warrant finish per AAMA 2605 for colour fade less than 5 units, maximum chalk rating of 8, and greater than 30% gloss retention. Warranty period for finish: 5 years from date Work is certified as substantially performed.

2 Products

2.1 **ACCEPTABLE MANUFACTURER(S) AND SYSTEM(S)**

- .1 All Aluminum work systems and components are to be provided by a single manufacturer to ensure a single source of responsibility for the Work of this Section.
- .2 Curtain Wall: 'ThermaWall 2600 Series' by Alumicor Limited, 'HP3252 Series' by CRL / U.S. Aluminum, '1600UT Curtain Wall' by Kawneer, or approved alternative by Toro Aluminum. Provide unique instance of 250 mm extended cap for CW32.
- .3 Aluminum windows: 'RainBlade 2970 ShadowLine' by Alumicor Limited, or approved alternative by CRL / U.S. Aluminum or Kawneer.
- .4 Operable Windows (vents): 'Phantom Vent 5000' by Alumicor Limited, or approved alternative by CRL / U.S. Aluminum or Kawneer.
- .5 Aluminum entrance/storefront framing (exterior): '3400 Series' by Alumicor Limited, 'IT451 Series' by CRL / U.S. Aluminum or '451T Storefront' by Kawneer.
- .6 Vestibule framing (interior): '1800 Series' by Alumicor Limited, '450 Series' by CRL / U.S. Aluminum, '450 Storefront' by Kawneer or approved alternative by Toro Aluminum.
- .7 Aluminum doors:
 - .1 Interior: '400A' by Alumicor Limited, '400 Series' by CRL / U.S. Aluminum, or approved alternative.
 - .2 Exterior: '400A Insuldoor' by Alumicor Limited, '400T Series' by CRL / U.S. Aluminum, or approved alternative.
- .8 Louvres: Pre-finished 25 mm thick aluminum louvre; 'Standard Architectural Louvres' by Toro Aluminum or approved alternative by BV Glazing Systems.

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. 'Dowsil 790' by Dow Consumer Solutions ; '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: 'Sopraseal 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 Aluminum Work 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; minimum 56 kg/m³, unfaced, semi-rigid mineral wool.
 - .1 'Thermafiber FireSpan' by Owens-Corning.
 - .2 'CurtainRock' by Rockwool Inc.

- .3 Thickness: As required to fill void.
- .4 Insulation fasteners: Stik-Clip with retaining washer.
- .17 Spray Foam Insulation: CAN/ULC S705.1, CFC free, polyurethane foam in place, closed cell, low expansion, one component air sealant, minimum density 15 kg/m3.
- .18 Door hardware: Manufacturer's standard heavy duty hardware, based on the following:
 - .1 Hinging device: extruded aluminum continuous gear hinge or 1 1/2 pair of heavy duty stainless steel butts complete with back up plates.
 - .2 Closing device: LCN 4040 Series closers with back up plates.
 - .3 Pull handles: Alumicor 1180, 25 mm diameter, anodized aluminum offset pull handles
 - .4 Push bars (for doors without panic hardware): Alumicor 246, 25 mm diameter, anodized aluminum push bar.
 - .5 Locking (basic locking): Adams Rite MS1850 Dead Lock with manufacturers standard cylinder on exterior and thumbturn on interior.
 - .6 Locking (panic hardware): Von Duprin 33/35A rim panic or Von Duprin 3547 vertical rod panic.
 - .7 Hold open devices (where required): Glynn Johnson GJ104S for door stop only applications; Glynn Johnson GJ104H for applications that require both a stop and hold open.
- .19 Insect screen (louvres): Extruded aluminum frames containing 14 x 18 heavy duty aluminum mesh in accordance with AAMA/WDMA/CSA 101/I.S.2/A440. Screen to be retained in place with turn clip type fixings.
- .20 Weatherstripping: Manufacturer's standard 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 Aluminum work in accordance with reviewed shop drawings and manufacturer's written instructions.
- .3 Fabricate, fit, and secure framing joints and corners accurately, with flush surfaces, and hairline joints. Apply frame sealant at joints to provide continuity of water and air barrier.
- .4 Conceal anchors, reinforcement and attachments from view. Fabricate reinforcement in accordance with design requirements.
- .5 Do not expose manufacturer's identification labels on aluminum assemblies.

- .6 Fabricate continuous sill flashings with intermediate anchor clips, and joint reinforcing, form to profile shown. Fabricate filler and closure pieces as necessary for a complete and weather tight installation.
- .7 Fabricate doors and frames complete with internal reinforcements, cut-outs, and recesses to accommodate finish hardware. Reinforce cut-outs to assure adequate strength.
- .8 Fabricate Aluminum work closures and trim from aluminum sheet. Form to profile shown. Make weathertight.
- .9 Double weatherstrip doors. Install weatherstripping in specially extruded ports and secure to prevent shrinkage or movement.
- .10 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 spandrel panel inner facing of galvanized sheet to form an airseal backpan. Wrap edges with galvanized sheet, enabling installation and minor movement of perimeter seal.
- .2 Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.
- .3 Provide integral reinforcing and stiffeners as required to reinforce panel against deflection caused by wind and suction loads.
- .4 Place continuous layer of insulation to airseal backpan with adhesive and impale clips and fasteners. Ensure there are not gaps between the insulation and airseal backpan.
- .5 Provide spacers as necessary to separate dissimilar metals.
- .6 Ventilate and pressure equalize the air space outside the exterior surface of the insulation, to the exterior.
- .7 Arrange fasteners and attachments to ensure concealment from view.
- .8 Glass panels: Consists of 6 mm thick spandrel glass to the exterior with insulated backpan to the inside. Insulation shall be in thickness as indicated on Contract Drawings, retained with stick clips. Seal all joints in shop with specified sealant, including perimeter seal at backpan. Colour to later selection by Consultant.

- .9 Metal panels: Consists of an exterior prefinished flush aluminum panel with panel stiffeners as required, to match colour of framing, with insulation core in thickness as indicated on Contract Drawings and galvanized sheet back-pan.

2.6 **FINISH**

- .1 Extrusion finish: 'Duranar XL' by PPG in accordance with AAMA 2605. Colour: to be selected by Consultant. Colour: Refer to Material Legend as indicated on Drawings.
- .2 Spandrel Extrusion finish: 'Duranar XL' by PPG in accordance with AAMA 2605.. Colour: Refer to Material Legend as indicated on Drawings.
- .3 Doors: 'Duranar XL' by PPG in accordance with AAMA 2605. Colour: to be selected by Consultant
- .4 Panel and sheet finish: As indicated on drawings to match adjacent extrusion finish.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Install Aluminum work in accordance with reviewed shop drawings, manufacturer's instructions, AAMA/WDMA/CSA 101/I.S.2/A440 and to meet requirements of authorities having jurisdiction.
- .2 Install work of this Section securely, in correct location, level, square, plumb, at proper elevations, free of warp or twist.
- .3 Apply isolation coating at 0.8 mm dry film thickness to prevent corrosive or electrolytic action between dissimilar materials such as aluminum to concrete, masonry, galvanized steel and similar conditions.
- .4 Install flashings, closures, and trim pieces.
- .5 Fill voids between aluminum framing and adjacent construction with foam insulation.
- .6 Install sills in maximum lengths possible. For sills over 1200 mm in length, maintain 3 mm to 6 mm space at each end.
- .7 Refer to Contract Drawings for glazing type locations. Install glazing in accordance with Section 08 80 00.

- .8 Spandrel panels:
 - .1 Set back pans to framing in sealant and apply sealant to cover screw heads to maintain air tight seal between back pans and framing.
 - .2 Adhere stick clips to metal back pans at 300 mm o.c. both ways. Apply insulation adhesive over entire surface of barrier and around clips held with adhesive.
 - .3 Cut insulation slightly over-size and press insulation boards firmly to barrier impaling them on clips without bending clips. Butt insulation boards tightly. install retainers to clips.
- .9 Automatic door operators to be supplied and installed by Section 08 70 00. Install doors and hardware to manufacturers' written instructions. Clean and adjust hardware for correct performance.
- .10 Install aluminum door manufacturer's standard weatherstripping at door frame perimeter. Install weatherstripping throughout entire length and width of doors at jambs and heads.
- .11 Install doors and hardware to manufacturers' written instructions. Clean and adjust hardware for correct performance.
- .12 Adjust operable parts for correct function.
- .13 Remove damaged or unacceptable Products and assemblies from Site and replace to Consultant's acceptance.
- .14 Install glass presence markers, in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.
- .15 Install custom wood slats at curved corners within curtain wall system in accordance with curtain wall manufacture written instruction . Ensure that slats are securely fastened in true vertical and horizontal manner. Clean and adjust hardware for correct performance.

3.3 **ERECTION TOLERANCES**

- .1 Tolerances: Non-cumulative.
 - .1 Maximum variation from plumb: 1.5 mm/3 m non-cumulative or 12 mm/30 m, whichever is less.
 - .2 Maximum misalignment of two adjoining members abutting in plane: 0.8 mm.
 - .3 Vertical and horizontal positions: +/- 3 mm.
 - .4 Racking of face: 6 mm, nil in elevation.
 - .5 Operable components: Consistent with smooth operation and weatherproof performance.
 - .6 Maximum perimeter sealant joint between Aluminum work and adjacent construction: 13 mm.

3.4 GLAZING PERIMETER AIRSEAL

- .1 Install glazing perimeter airseal at entire perimeter of each insulating glass unit to achieve an airseal from insulating glass unit to curtain wall frame. Do not obstruct path of cavity drainage and air pressure equalization.
- .2 Perform sealant work in accordance with manufacturer's written requirements.

3.5 AIRSEAL TRANSITION MEMBRANE

- .1 Install primer and airseal transition membrane in accordance with manufacturer's instructions and reviewed shop drawings.
- .2 Overlap airseal transition membrane 75 mm minimum and lap in direction of waterflow. Hand roll membrane to ensure 100% contact and adhesion to substrates.
- .3 Coordinate airseal transition to adjacent parts of Work. Continuity of weather and air seal to be maintained throughout curtain wall and at interface with adjacent components or systems.
- .4 Provide terminations fabricated from same material as airseal transition membrane or material recommended by membrane manufacturer at sills, lintels, openings, and where horizontal surfaces intersect with vertical surfaces to ensure moisture is shed to exterior.

3.6 JOINT BACKING AND ALUMINUM WORK SEALANT

- .1 Prepare substrate surface and mask as recommended by sealant manufacturer.
- .2 Install joint backing and sealant at Aluminum work and perimeter joints for weather tight installation in accordance with sealant manufacturer's instructions. Tool sealant. Remove excess sealant.

3.7 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 certification labelling when directed by Consultant, in writing.
- .4 Wash Aluminum work with solution of mild detergent in warm water, with particular attention to recesses and corners. Wipe surfaces clean and dry.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, tool, equipment and services necessary for interior glazing work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 AAMA CW-10, Care and Handling of Architectural Aluminum from Shop to Site.
- .2 ANSI H35.1M, Alloy and Temper Designation Systems for Aluminum (Metric).
- .3 ASTM B209M, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .4 ASTM B221M, Specification for Aluminum-Alloy Extruded Bars, Rods, Wires, Profiles and Tubes.
- .5 ASTM C920, Specification for Elastomeric Joint Sealants.
- .6 ASTM F738M, Specification for Stainless Steel Metric Bolts, Screws, and Studs.
- .7 CSA W59-M, Welded Steel Construction (Metal Arc Welding).

1.3 **DESIGN REQUIREMENTS**

- .1 Design the entire interior glazing system, including framing and supports as required.
- .2 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.
- .3 Design anchorage inserts for installation as part of other Sections of Work. Design anchorage assemblies with a minimum safety factor of 2.0.
- .4 Design members to withstand dead load and live loads calculated in accordance with OBC and applicable local regulations, to maximum allowable deflection of $1/360$ of span.

1.4 **SUBMITTALS**

- .1 Shop Drawings:
 - .1 Submit Shop Drawings in accordance with Section 01 33 00 indicating:
 - .1 Plans, sections, details, type of extrusions, profiles, thicknesses, seals, finishes, panels, operating components, 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.

- .2 Samples:
 - .1 Submit two samples of following in accordance with Section 01 33 00:
 - .1 250 mm long samples of each type of extrusion and finish.
 - .2 250 x 200 mm samples of glass.
- .3 Reports/Certificates:
 - .1 Submit documentation to substantiate ten years of experience in glazed partition manufacture and installation.
 - .2 Submit written manufacturer's certificate certifying compliance with the specifications.
- .4 Close-out submittals: Submit data for incorporated into the Operations and Maintenance Manual as part of Section 01 78 00.

1.5 **QUALITY ASSURANCE**

- .1 Retain a licensed Professional Engineer, registered in Province of Ontario, to perform following services for interior glazing work:
 - .1 Design of interior glazing system.
 - .2 Review, stamp, and sign Shop Drawings.
 - .3 Conduct on-Site inspections and prepare and submit inspection reports.

1.6 **DELIVERY, STORAGE, AND HANDLING**

- .1 Handle glazed partition work in accordance with AAMA CW-10.
- .2 Protect 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.

1.7 **EXTENDED WARRANTY**

- .1 Submit an extended warranty for glazed partition work in accordance with General Conditions, except that warranty period is extended to 5 years.
 - .1 Warrant against failure to meet the design criteria and requirements.
 - .2 Coverage: Complete replacement including affected adjacent work.

2 Products

2.1 **ACCEPTABLE MANUFACTURER(S) AND SYSTEM(S)**

- .1 Glazing: The choice of glazing for this project shall conform to specified Design Requirements, reviewed shop drawings, and Authorities having jurisdiction: Refer to Section 08 80 00 for glazing types.

- .2 Glass Partition Systems:
 - .1 Partitions: Aluminum 'U' channel frame with top, bottom, and side channel, concealed installation, to accommodate glazing up to 55 mm thick, complete with dry-fit gaskets; Supplied by C.R. Canada or approved alternative.
 - .2 Glass: in accordance with Section 08 80 00.
 - .1 Single glazed system.
- .3 Fixed and Sliding Door Systems:
 - .1 Multi-Track fixed and sliding doors, 'Whisperglide' by Alumicor Limited. or approved alternative.
 - .2 Glass: in accordance with Section 08 80 00.
 - .1 Single glazed system.
- .4 Structural perimeter channel:
 - .1 Partitions: Aluminum 'U' channel frame with top and bottom channel, to accommodate glazing from 10 to 19 mm thick, complete with dry-fit gaskets 'SCSA3812SL by C.R. Laurence or 'Bottom Dri-Fit U-Channel' by Dormakaba.
 - .2 Glass: tempered or laminated glass with structural silicone vertical joints in accordance with Section 08 80 00.
 - .3 Material: Extruded aluminum with PVDF finish; 'Duranar XL' by PPG in accordance with AAMA 2605. Colour: Refer to Interior Glazing Assembly Schedule for colours.

2.2 MATERIALS

- .1 General: All materials under work of this Section, including but not limited to, sealants and coatings 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 316. Size as shown.
- .5 Glass, glazing and structural silicone glazing materials: In accordance with Section 08 80 00.
- .6 Glazing gasket: EPDM roll-in glazing gasket.
- .7 Frame sealant: Type as recommended by the glazed partition work manufacturer.
- .8 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.

- .9 Anchors, clips, and angles: Stainless steel.
- .10 Flashings, closures and trim: 1 mm minimum aluminum sheet, finish to glazed partition.
- .11 Screws, bolts and other fasteners: ASTM F738M; colour match frame colour and finish.

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, fit, and secure framing joints and corners accurately, with flush surfaces, and hairline joints. Apply frame sealant at joints for weatherproof seams.
- .3 Conceal anchors, reinforcement and attachments from view. Fabricate reinforcement in accordance with design requirements.
- .4 Do not expose manufacturer's identification labels on glazed partition assemblies.
- .5 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.
- .6 Fabricate glazed partition work closures and trim from aluminum sheet.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Install single glazed system work in accordance with reviewed Shop Drawings, manufacturer's written instructions.
- .2 Install work of this Section securely, in correct location, level, square, plumb, at proper elevations, free of warp or twist.
- .3 Install flashings, closures, and trim pieces.
- .4 Install sills in maximum lengths possible. For sills over 1200 mm in length, maintain 3 mm to 6 mm space at each end.

- .5 Refer to Contract Drawings for glazing type locations. Install glazing in accordance with Section 08 80 00.
- .6 Adjust operable parts for correct function.
- .7 Remove damaged or unacceptable Products and assemblies from Site and replace to Consultant's acceptance.
- .8 Install glass presence markers, in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

3.3 **ERECTION TOLERANCES**

- .1 Tolerances: Non-cumulative.
 - .1 Maximum variation from plumb: 1.5 mm/3 m non-cumulative or 12 mm/30 m, whichever is less.
 - .2 Maximum misalignment of two adjoining members abutting in plane: 0.8 mm.
 - .3 Vertical and horizontal positions: +/- 3 mm.
 - .4 Racking of face: 6 mm, nil in elevation.
 - .5 Operable components: Consistent with smooth operation and weatherproof performance.
 - .6 Maximum perimeter sealant joint between glazed partitions and adjacent construction: 12 mm.

3.4 **JOINT BACKING AND GLAZED PARTITION WORK SEALANT**

- .1 Prepare substrate surface and mask as recommended by sealant manufacturer.
- .2 Install joint backing and sealant at glazed partition work and perimeter joints for sound tight installation in accordance with sealant manufacturer's instructions. Tool sealant. Remove excess sealant.

3.5 **CLEANING**

- .1 Maintain glazed partition work, inside and outside, in clean condition throughout construction period.
- .2 Remove labels, protective material, and glass presence markers from prefinished surfaces.
- .3 Wash glazed partition work with solution of mild detergent in warm water, with particular attention to recesses and corners. Wipe surfaces clean and dry.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for unit skylight work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 AAMA 611, Voluntary Standards for Anodized Architectural Aluminum.
- .2 AAMA/WDMA/CSA 101/I.S.2/A440, Standard Specification for Windows, Doors, and Unit Skylights.
- .3 CAN/CGSB-19.13-M, Sealing Compound, One-Component, Elastomeric, Chemical Curing.

1.3 **DESIGN REQUIREMENTS**

- .1 Design skylights in accordance to AAMA/WDMA/CSA -101/I.S.2/ A440, to the following performance levels:
 - .1 Minimum performance grade (PG): 30.
 - .2 Minimum design pressure (DP): 1440 Pa.
 - .3 Minimum positive structural test pressure (STP): 2880 Pa.
 - .4 Minimum negative structural test pressure (STP): - 2160 Pa.
 - .5 Minimum water penetration test pressure: 220 Pa.

1.4 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Elevations, sections and details, dimensions, thicknesses, materials, fastening devices, installation details, and finishes.
- .3 Closeout submittals:
 - .1 Submit cleaning and maintenance for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

2 Products

2.1 **MANUFACTURED UNITS**

- .1 Curb mounted skylights: Fixed curb mounted unit skylight with extruded aluminum frame and cover. Insulated unit consisting of tempered and laminated glass panes with low E coating and argon filled air space. Internal drainage to weep to the exterior. 'Model FCM' by Velux or approved alternative by Artistic Skylight Domes Ltd., or Slimlite Skylights Ontario Inc.
- .2 Fasteners: Stainless steel screws to manufacturers standard.
- .3 Finish: Clear anodized to AAMA 611 per Aluminum Association Designation System for Aluminum Finishes AA-M12C22A31.

3 Execution

3.1 **EXAMINATION**

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

3.2 **PREPARATION**

- .1 Verify all dimensions affecting work of this Section from site. Ensure adjacent and adjoining materials, flashings, curbs, framing, anchors, fastenings and the like, are properly set and in readiness to accept the structural supports and glazed skylight.

3.3 **INSTALLATION**

- .1 Install skylights in accordance with reviewed shop drawings, manufacturer's written instructions, and authorities having jurisdiction.
- .2 Install components plumb, level and in proper alignment. Secure preformed curb assembly to substrate.
- .3 Metals in contact with dissimilar metals, concrete or other cementitious surface shall have the surfaces protected by a suitable inert material.
- .4 Conceal all fasteners or set flush with surface unless otherwise indicated.
- .5 Adjust and seal assembly with provision for expansion and contraction of components. Secure and seal frame to curb.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for finish hardware work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ANSI/BHMA A156.19, Power Assist and Low-Energy Power-Operated Doors.
- .2 BHMA, Builders Hardware Manufacturing Association.
- .3 NFPA 80, Standard for Fire Doors and Other Opening Protectives.

1.3 **DESIGN REQUIREMENTS**

- .1 Automatic door equipment:
 - .1 Design handicap door system comprising of low energy power operator with optional push and go door system as defined in ANSI/BHMA A156.19.
 - .2 Design system operator to activate if one push button from either side of door is pushed. Actuated door shall open slowly to back check (80°) in 3 to 6 seconds and to full open position in 4 to 7 seconds. Door shall remain open for period set to suit requirements (period of 5 to 30 seconds). After time delay door shall close by spring in door operator from 90° to 10° in 3 to 6 seconds from 10° to fully closed in 1-1/2 to 2 seconds.

1.4 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00: indicating compliance with reference standards, transportation, storage, handling and installation requirements.
- .2 Shop Drawings:
 - .1 Submit Shop Drawings and complete hardware lists in accordance with Section 01 33 00 indicating:
 - .1 Door locations, sizes, hardware manufacturer's catalogue numbers, finish symbols and quantities required.
 - .2 Locations and mounting heights of each type of hardware.
 - .2 Supply templates and required information to door and frame manufacturer to enable accurate sizes, locations of cut-outs and reinforcement for hardware.
 - .3 Submit templates to required trade to arrange for provisions for accurate setting and fitting of hardware.
 - .4 Automatic door equipment: All connections, attachments, reinforcing, anchorage and location of exposed fastenings.
- .3 Samples:
 - .1 Submit 2 samples in accordance with Section 01 33 00 of each item that is different from hardware specified and include manufacturer's parts lists and installation instructions.

- .2 Submit hardware component samples illustrating style, colour and finish. Tag samples identifying applicable Specification article number, brand name and number, finish, building location, date and catalogue number.
- .3 Do not order hardware until samples have been accepted. Submit new samples to replace rejected samples. Supply hardware and finishes identical to each accepted sample.
- .4 Closeout submittals:
 - .1 Submit the following in accordance with Section 01 78 00 for each Product for incorporation into Operation and Maintenance Manual:
 - .1 Maintenance data.
 - .2 Operating instructions and safety precautions.
 - .3 Parts list with name and address of supplier.
 - .4 Lubrication schedule and type of lubricant recommended.
 - .5 Keys, tools and special devices.
 - .6 Inspection procedures related to preventive maintenance.

1.5 **QUALITY ASSURANCE**

- .1 General:
 - .1 Manufacturers: Companies specializing in manufacturing door hardware and registered with BHMA.
 - .2 Hardware supplier: Company specializing in supplying commercial door hardware and acceptable to manufacturer.
- .2 Certifications:
 - .1 Employ an Architectural Hardware Consultant to prepare hardware schedule and inspect completed installation and certify that hardware has been installed in accordance with manufacturer's printed instructions, Authorities having Jurisdiction and as specified.
 - .2 Submit manufacturer's certificate that finish hardware and fire rated hardware meets specified requirements.

1.6 **DELIVERY, STORAGE, AND HANDLING**

- .1 Be responsible for packaging of hardware, on a set by set basis. As material is received from various manufacturers identify it to correspond to Hardware List symbols.
- .2 Label packages legibly, indicating manufacturer's number, types, sizes, opening number and Hardware List reference number. Wrap hardware and include in package, screws, bolts and fastening necessary for correct installation. If hardware package is not complete, pay additional charges incurred by installer.
- .3 Deliver hardware to Site packaged, labelled and cross-referenced to hardware list for each item and its scheduled installation location.
- .4 Accept Products of this Section on Site and ensure that each item is undamaged.

- .5 Catalogue and store hardware in secure area.

2 Products

2.1 GENERAL

- .1 Carefully check and verify Hardware List against Contract Drawings to ensure that hardware listed can be used as specified. Inform Consultant of concerns regarding quality, quantity, operation or function of hardware selected:
 - .1 Verify hand of doors, examine details on Contract Drawings and at Site to ensure hardware supplied can be correctly installed and is correct for work as constructed.
 - .2 Select hardware in accordance with applicable codes and regulations and to approval of local Fire Marshal.
 - .3 Replace and pay for defective hardware including hardware which was incorrectly selected, and remedial and installation costs.
- .2 Ensure that hardware selected will function correctly, meets Contract requirements and Ontario Building Code and authorities having jurisdiction.
- .3 Ensure that each hardware item is of same type, design and by same manufacturer.
- .4 Manufacturer's names or trade marks are not permitted on exposed surfaces of hardware.
- .5 Include in packing slip a list of parts, name of supplier and door number in which lock is to be installed.
- .6 Hardware for fire rated and labelled door and frame assemblies: ULC listed or as accepted by authorities having jurisdiction.
- .7 Fire rated assemblies:
 - .1 Hardware: Selected and installed in accordance with applicable codes and regulations, NFPA-80 and to approval of Ontario Fire Marshal.
 - .2 Fire rated doors: ULC labelled hardware. Submit written certification of conformance to ULC requirements for each type of hardware prior to delivery.
 - .3 Locksets and latchsets on fire rated doors: 19 mm throw minimum.

2.2 ACCESSORIES

- .1 Items to be attached to masonry or concrete with expandable shields, lag screws, bolts or other fastening devices as required. Exposed screws: Stainless steel, Phillips or Robertson heads.

2.3 FINISHES

- .1 Metal finishes: Free from defects, clean, unstained and of a uniform colour for each type of finish required. Exposed surfaces and anchors: Specified finish symbol of item.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Install hardware in accordance with reviewed Shop Drawings, manufacturer's installation instructions, and applicable Codes and regulations.
- .2 Install hardware in accordance with hardware templates.
- .3 Adjust fixed and operable hardware for correct clearances and function.
- .4 Mount hardware measured from finished floor to centre of hardware, unless indicated otherwise or required by Code:
 - .1 Top hinge: 250 mm from head of door to top.
 - .2 Bottom hinge: 265 mm from finished floor to bottom of hinge.
 - .3 Intermediate hinge: Equal distance between top and bottom hinge.
 - .4 Locksets, latchsets: 1000 mm.
 - .5 Panic device crossbar: 1000 mm.
 - .6 Push plates: 1100 mm to bottom of plates.
 - .7 Guard bars: 1100 mm.
 - .8 Door pulls: 1100 mm to bottom of pulls.
 - .9 Blank strike: 1450 mm.
 - .10 Blank fronts: 1450 mm.
- .5 Automatic door equipment:
 - .1 Install automatic door operators, controls and accessories for doors indicated in accordance with reviewed shop drawings, manufacturer written instructions and to meet requirements of authorities having jurisdiction.
 - .2 Doors shall operate manually as though equipped with manual door closers, without damage to automatic door components, in event of power failure or in event of power termination.
 - .3 Coordinate this work with applicable Sections as required.
 - .4 Power supply to each door operator and wiring shall be provided by Division 26 - Electrical. Make connections at operators and at control panel and supply and install each electrical work between operators and activating controls. Comply with requirements of Division 26 - Electrical. All wiring shall be concealed and where exposed shall be run in conduit. Location of exposed wiring shall be subject to Consultant's approval.
- .6 Include for supply and installation of wiring for electric strikes from electrical junction box to electric strike hardware.
- .7 Locate door stops to contact doors 75 mm from latch edge.

- .8 Install hardware and trim square and plumb to doors.
- .9 Replace wrappings for hardware provided by manufacturer after installation.
- .10 Safeguard keys to keep them out of unauthorized hands, tag them with door number, and deliver them to person designated by Consultant at building completion.

3.3 **FIELD QUALITY CONTROL**

- .1 Have hardware inspected after installation by hardware supplier's representative, obtain certification in writing that hardware has been supplied and installed in accordance with Specifications and hardware manufacturer's instructions and is functioning correctly.
- .2 Inspect fire rated openings to ensure they are installed in compliance with NFPA 80 requirements and Authorities having Jurisdiction.
- .3 Test access control system and electrified hardware devices for proper operation. Verify electric door release hardware operates properly upon activation of fire alarm system.

3.4 **ADJUSTING**

- .1 Verify under work of this Section, that installed hardware functions properly.
- .2 Adjust hardware so that latches and locks operate smoothly and without binding, and closers act positively with the least possible resistance in use. Lubricate hardware if required by manufacturer's instructions.
- .3 Adjust doors with self closing devices or automatic closing devices for proper operation after the HVAC system is balanced and adjusted. Verify spring power of non sized door closers is properly adjusted.

3.5 **CLEANING**

- .1 Remove wrappings at completion of the Project and clean hardware in accordance with manufacturer's instructions.

3.6 **HARDWARE GROUPS/SCHEDULE**

- .1 Hardware groups/schedule:
 - .1 Provide hardware schedule to Consultant for review indicating products, materials and finishes.
 - .2 Do not order products until schedule has been reviewed by the Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment, tools, and services necessary for glass and glazing work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ANSI Z97.1, For Safety Glazing Materials used in Buildings - Safety Performance Specifications and Methods of Test.
- .2 ASTM C920, Specification for Elastomeric Joint Sealants.
- .3 ASTM C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- .4 ASTM C1376, Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
- .5 ASTM D2240, Test Method for Rubber Property - Durometer Hardness.
- .6 ASTM E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.
- .7 CAN/CGSB-12.1-M, Tempered or Laminated Safety Glass.
- .8 CAN/CGSB-12.3-M, Flat, Clear Float Glass.
- .9 CAN/CGSB-12.8, Insulating Glass Units.
- .10 CAN/CGSB 12.11, Wired Safety Glass.
- .11 Glass Association of North America (GANA) Glazing Manual.
- .12 NFPA 80, Standard for Fire Doors and Other Opening Protectives.
- .13 ULC CAN4 S104-M, Standard Method for Fire Tests of Door Assemblies.
- .14 ULC CAN4 S106-M, Standard Method for Fire Tests of Window and Glass Block Assemblies.

1.3 **DESIGN REQUIREMENTS**

- .1 Glass design:
 - .1 Design glass using a probability of breakage of 8 lites per 1000 at the first application of design load.
 - .2 Perform stress analysis. Design units to accommodate live, dead, lateral, wind, seismic, handling, transportation, and erection loads.

- .3 Perform a thermal stress analysis on each glass unit with Low-E coating and provide heat strengthening and/or tempered units as necessary to prevent thermal breakage.
 - .4 Perform a thermal stress analysis on each insulating thermal unit and provide heat strengthening and/or tempered units as necessary to prevent thermal breakage.
 - .5 Where required, design glazing units so as not to allow thermal stress fracture due to heat build-up behind insulating units.
 - .6 Roller wave:
 - .1 Heat treated flat glass to be by horizontal (roller hearth) process with inherent roller wave distortion parallel to the bottom edge of the glass as installed.
 - .2 Maximum peak to valley roller wave 0.08 mm in the central area and 0.20 mm within 267 mm of the leading and trailing edge or 100 millidiopter over 95% of the glass surface.
 - .3 Maximum bow and warp 0.79 mm per 300 mm.
 - .4 Roll distortion is to run parallel to the width dimension when installed in the building.
 - .7 Coordinate with applicable Sections as required to meet intended energy and performance requirements for insulating glass units.
- .2 Structural glazing:
- .1 Carry out design of structural silicone joints by rational analysis including all movements specified herein. Maximum stress shall not exceed 138 kPa (20 psi) in tension or shear for short term loading. Maximum stress in shear for long term loading due to the dead load of glass shall not exceed 7 kPa (1 psi) or the limit imposed by sealant manufacturer, whichever is less.
 - .2 The joint shall be essentially rectangular in shape and shall include no internal corners which could precipitate tearing or create high local stresses.
 - .3 Single Source Responsibility for Sealants, Gaskets and Other Glazing Accessories: In order to ensure consistent quality of performance, provide all glazing sealants and seals from a single manufacturer.
 - .4 Preconstruction Compatibility and Adhesion Testing: Submit to sealant manufacturer, samples of each glass, gasket, glazing accessory and glass-framing member that will contact or affect glazing sealants for compatibility and adhesion testing. Schedule submission of test samples to provide sufficient time for testing and analysis of results to prevent delay in the progress of work.
- .3 Limit glass deflection to flexural limit of glass with full recovery of glazing materials.
- .4 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.
- .5 Design glazing in accordance with City of Toronto Green Development Standard - Bird Friendly Development Guidelines.
- .6 Fire Protective Rated Glass: Each lite shall bear permanent, nonremovable label of ULC certifying it for use in tested and rated fire protective assemblies.

1.4 SUBMITTALS

- .1 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating as a minimum:
 - .1 Fabrication and erection of glazing elements indicating materials, thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.
 - .2 To sealant manufacturer for their review and approval of tensile bead contact/bite dimension and thickness.
- .2 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00
 - .2 Submit one sample of each type of glass.
 - .1 300 x 300 mm of each type of insulating glass unit, complete with each different Low-E coating.
 - .2 300 x 300 mm of each colour of spandrel glass.
 - .3 300 x 300 mm of Mirror.
 - .4 300 x 300 mm of fire rated glass.
 - .5 300 x 300 mm of each colour of insulating panels.
 - .6 300 x 300 mm of glass film.
- .3 Certificates:
 - .1 Submit manufacturer's certification that glass and glazing materials are compatible.
 - .2 Design glass balustrades to meet OBC Supplementary Guideline SB-13.
- .4 Reports:
 - .1 Submit compatibility and adhesion test reports from sealant manufacturer indicating that glazing materials were tested for compatibility and adhesion with glazing sealants. Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed for adhesion.
 - .2 Compatibility test report from manufacturer of insulating glass edge sealant, indicating that glass edge sealants were tested for compatibility with other glazing materials including sealants, setting blocks, edge blocks and any other material that contacts or can affect the edge seal.
- .5 IGMAC Compliance Audit: Submit in accordance with Section 01 33 00, a written certification of successful completion of a Compliance Audit within the last six months.
- .6 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.5 **QUALITY ASSURANCE**

- .1 Insulating glass unit fabricators shall be a certified member of the Fenestration and Glazing Industry Alliance (FGIA). FGIA members must participate in the certification program and shall have successfully passed a Compliance Audit within the last six months.
- .2 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of glazing units of a similar size and nature.
- .3 Fire Protective Rated Glass: Each lite shall bear permanent, nonremovable label of ULC certifying it for use in tested and rated fire protective assemblies.
- .4 Each lite fire rated wire glass shall bear permanent, nonremovable label of ULC certifying it for use in tested and rated fire protective assemblies.

1.6 **SITE CONDITIONS**

- .1 Glaze with compounds, sealants, or tapes only when glazing surfaces are at temperatures over 4°C, and when positive that no moisture is accumulating on them from rain, mist, or condensation.
- .2 When temperature of glazing surfaces is below 4 °C, obtain from Consultant and material manufacturer approval of glazing methods and protective measures which will be used during glazing operations.

1.7 **EXTENDED WARRANTY**

- .1 In accordance with Section 08 43 00 and 08 44 00

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

- .1 Glass manufacturers:
 - .1 AGC Flat Glass.
 - .2 Cardinal Glass Industries.
 - .3 Guardian Industries.
 - .4 Viracon Inc.
 - .5 Vitro Architectural Glass (formerly PPG Industries Ltd.)
 - .6 Or approved alternative.

2.2 MATERIALS

- .1 General:
 - .1 All materials under work of this Section, including but not limited to, primers, coatings, sealers, sealants, adhesives and cleaners are to have low VOC content limits.
 - .2 All coatings of a similar type shall be applied in a single production run to ensure colour match.
 - .3 Edges of glass shall be free from spalls, flake chips or rough chips which would be either visible or compromise the adhesion of the exterior weather seal or reduce the strength of glass when subjected to temperature differentials.
- .2 Float glass (**FGL**): CAN/CGSB-12.3-M; clear, glazing quality, minimum 6 mm thick. Clear or tinted as indicated. Heat strengthened as required.
- .3 Tempered glass (**TG**):
 - .1 **TG.1** (Interior glass): CAN/CGSB-12.1-M, Type 2, Class B, Category II, clear tempered, glazing quality, minimum 6 mm thick in insulated glass units, low iron content, colourless and minimum 10 mm thick in interior screens. 'Acuity' by Vitro Architectural Glass (formerly PPG Industries Ltd.).
 - .2 **TG.2** (Exterior glass): CAN/CGSB-12.1-M, clear, tempered, glazing quality, minimum 6 mm thick in insulated glass units, low iron content, colourless; 'Acuity' by Vitro Architectural Glass (formerly PPG Industries Ltd.).
- .4 Tempered laminated glass (**TLG**): to CAN/CGSB-12.1, Category II, consisting of top layer of 9 mm thick clear tempered glass, 0.8 mm thick clear PVB interlayer, and bottom layer of 9 mm thick clear tempered glass. Total thickness: 18.8 mm thick.
- .5 Laminated glass (**LG.1**): to CAN/CGSB-12.1, Category II, consisting of top layer of 8 mm thick clear heat strengthened glass, 0.8 mm thick clear PVB interlayer, and bottom layer of 8 mm thick clear heat strengthened glass. Total thickness: 16.8 mm thick.
- .6 Laminated glass (**LG.2**): to CAN/CGSB-12.1, Category II, consisting of top layer of 10 mm thick, clear low iron tempered glass, 1.2 mm thick white translucent PVB interlayer, and bottom layer of 10 mm thick, clear low iron tempered glass. Overall glass thickness to be 21.2 mm minimum.
- .7 Fire rated glass (**FRGL**): 20 min. to 90 min. fire rating tested to ULC CAN4 S104-M and ULC CAN4 S106-M, 5 mm thick or as otherwise noted on Door Schedule with appropriate labelling stating fire rating and approval, clear polished glass. Firelite by Nippon Electric Glass Company Ltd. or approved alternative.
- .8 Spandrel glass (**SGL**): ASTM C1048, Condition B, 6 mm thick heat strengthened glass, with water-based silicone emulsion coating applied to backside, 'Opaci-Coat 300' by ICD High Performance Coatings or approved alternative. Colour: To the later selection of the Consultant.

- .9 Ceramic frit glass (**CFG**): 6 mm thick unless otherwise indicated, glass with colour of ceramic frit coating applied to surface #1. Colours: 'Viraspan V-175 High Opacity White'. Screen transferred to glass surface and heat cured. 'Silk-Screen, Viraspan Design' by Viracon , 'Birdsmart Glass' by Vitro Architectural Glass (formerly PPG Industries Ltd.) or approved alternative. Provide the following frit patterns:
 - .1 **CFG.1**: Bird-Friendly frit pattern as indicated on Drawings.
 - .2 **CFG.2**: Custom bird-friendly frit pattern, supplied by Architect, applied on surface #1 and #2.
- .10 Frosted glass (**FR/GL**): CAN/CGSB-12.1-M, tempered glass with frosted surface 'Rolled Patterned' by AGC Flat Glass or approved alternative in frosting pattern as selected by Consultant. Thickness as indicated on drawings.
- .11 Glass film: Style as selected by Consultant and manufactured by 3M or approved alternative. Application pattern as indicated on drawings.
- .12 Silvered mirror glass (**MIR**):
 - .1 To ASTM C1503, 6 mm thick, laminated safety mirror glass fabricated with polished plate or float glass. Mirror backing shall be resistant to sulphur and hydrogen sulphide fumes. Polish and round all corners of mirrors.
 - .2 Mirror attachment accessories:
 - .1 Mirror adhesive: Chemically compatible with mirror coating and wall substrate.
- .13 Insulating glass units:
 - .1 To CAN/CGSB-12.8-M, ASTM E2190 and IGMA requirements utilizing approved stainless steel edge spacer. Dual and triple seal with a PIB primary seal and silicone secondary seal.
 - .2 To comply with IGMA labelling requirements to be considered certified. Materials, excluding the glass, shall be from the same manufacturer as those employed for the certification of the insulating glass units.
- .14 Argon gas: 100% pure. Argon gas to be used to fill air space at all insulated glass units.
- .15 Low-E coating (Soft coat): ASTM C1376, high performance sputtered low-E coating. Provide insulating glass units with low-E coating edge deletion and low-E coating. Apply low-E coating to surface three unless otherwise indicated. 'Solarban 70' by Vitro Architectural Glass (formerly PPG Industries Ltd.) Or approved alternative
- .16 Glazing and rebate primers, sealants, sealers, and cleaners: Compatible with each other. Type as recommended by sealant, spline, and glass manufacturer.
- .17 Glazing sealant: Silicone sealant as recommended by glazing manufacturer. Verify compatibility with insulating glass unit secondary sealant.

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- .18 Glazing sealant (structural glazing - exterior):
 - .1 Silicone, One Part in accordance with ASTM C920, Type S or M, Grade NS, Class 25.
 - .2 Structural glazing tensile bead: 'Proglaze SSG' by Tremco or 'Dowsil 795' by Dow Consumers Solution.
 - .3 Structural glazing weather bead: 'Spectrem 2 Sealant' by Tremco or 'Dowsil 795' by Dow Consumers Solution.
 - .4 Structural glazing (factory glazed): Two-part, neutral cure silicone sealant, 'Proglaze II' by Tremco or 'Dowsil 983' by Dow Consumers Solution.
 - .5 Colour: Colour to be selected by the Consultant from full colour range.
 - .19 Glazing sealant (structural glazing - interior):
 - .1 Silicone, One Part in accordance with ASTM C920, Type S or M, Grade NS, Class 25.
 - .2 Structural glazing tensile bead: 'Proglaze SSG' by Tremco or 'Dowsil 795' by Dow Consumers Solution.
 - .3 Structural glazing (factory glazed): Two-part, neutral cure silicone sealant, 'Proglaze II' by Tremco or 'Dowsil 983' by Dow Consumers Solution.
 - .4 Colour: Colour to be selected by the Consultant from full colour range.
 - .20 Security sealant: ASTM C920; Type S, Grade NS, Class 50. One-component, self-priming, neutral cure silicone sealant. 'Dowsil 995' by Dow Consumer Solution or approved alternative.
 - .21 Heel & toe bead: Silicone sealant as recommended by glazing manufacturer.
 - .22 Glazing gasket: 'Visionstrip' or Polyshim II' by Tremco Ltd., glazing seal, size as recommended by manufacturer.
 - .23 Glazing tape: 'Polyshim II' glazing tape EPDM shim.
 - .24 Glazing tape (fire rated glass): Closed cell polyvinyl chloride (PVC) foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2 percent. Glass panels that exceed 1,393 sq. inches for 90-minute ratings must be glazed with fire-rated glazing tape supplied by manufacturer.
 - .25 Glazing splines: EPDM or neoprene, extruded shape to suit glazing channel retaining slot, colour as selected.
 - .26 Setting blocks (regular): EPDM, 80 - 90 Shore A durometer hardness to ASTM D2240, sized to suit glazing method, glass unit weight and area.
 - .27 Setting Block (Structural Glazing): Silicone setting blocks with Shore, Type A durometer hardness of 85, plus or minus 5 to ASTM D2240, sized to suit glazing method, glass unit weight and area.
 - .28 Edge blocks: EPDM, 60-70 Shore A Durometer hardness, self adhesive on face, sized with 3 mm clearance from glass edge and spanning glass thickness(es).
 - .29 Glass presence markers: Easily removable, non-residue depositing.
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- .30 Screws, bolts and fasteners: Type 304 stainless steel.

2.3 **GLAZING AND FILM SCHEDULE**

- .1 Glass and film types shall be as indicated on Drawings unless otherwise required due to thermal stress analysis.

2.4 **FABRICATION**

- .1 Verify glazing dimensions on Site.
- .2 Clearly label each glass lite with maker's name and glass type. Ensure labels are easily removable, non-residue depositing type. Do not remove labels until after Work is accepted by Consultant.
- .3 Fabricate glazing not less than 3 mm smaller than rebate size in either dimension; allow for edge spacers, shims, and setting blocks as necessary.
- .4 Work shall have smooth finished surfaces free from distortion and defects detrimental to appearance and performance.
- .5 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.
- .6 Grind and polish a 1.5 mm arris to both edges of exposed glazing at locations where glazing is not encapsulated in framing and where edges are exposed to occupants.
- .7 Fabricate argon filled thermal units with air space filled minimum 90% with argon gas.
- .8 Grind a 1.5 mm arris to the front corner of edges of mirrors which are to be set into ceramic tile. Provide polished pencil round edges to frameless surface-mounted mirrors.
- .9 Provide bird warning glass in accordance with City of Toronto Green Development Standard - Bird Friendly Development Guidelines. Style as selected by Consultant.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify that openings for glazing are correctly sized and within tolerance.

- .3 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.
- .4 Laminated glass edges shall be completely covered by tape to protect against sealants and water if required by manufacturer.

3.2 **PREPARATION**

- .1 Clean contact surfaces with solvent and wipe dry.
- .2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- .3 Prime surfaces scheduled to receive sealant.

3.3 **INSTALLATION**

- .1 Provide glazing in accordance with FGIA recommendations. Provide continuous contact between glazing tapes and gasket to the glazing.
- .2 Install glazing to the work of Sections 08 11 13, and 08 44 00.
- .3 Provide neat, straight sight lines. Trim excess glazing tape flush with top of stops and fixed leg of frames.
- .4 Remove protective coatings, glazing stops, clean rebate and glass contact surfaces with solvent, wipe dry.
- .5 Apply primer/sealer to contact surfaces, prior to glazing.
- .6 Apply glazing tape as per manufacturer's instructions including recommended corner sealant.
- .7 Use setting blocks at 1/4 points and spacers to centre glass unit in frame.
- .8 Install glazing in accordance with reviewed shop drawings and manufacturer's written instructions. Install glazing with full contact and adhesion at perimeter. Maintain edge clearance recommended by glass manufacturer.
- .9 Apply a continuous heel bead of sealant around perimeter of inboard lite of the sealed unit and the metal framing.
- .10 Re-install glazing stops ensuring continuous contact and rattle-free installation. Do not distort glass. Trim tape protruding more than 2 mm above stop.
- .11 Install glazing gasket in accordance with manufacturer's recommendations.
- .12 Do not cut or abrade tempered, heat treated, or coated glass.
- .13 Install glass presence markers in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

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- .14 Remove, dispose of, and replace broken, cut, abraded glass, and defective glass including but not limited to production dimples, roller wave or marks, tong marks, chips, cracks, etc.
 - .15 Exterior glass: Glaze units with gasket on exterior side and glazing tape on interior side. Seal gap between glazing and stop with sealant to depth equal to bite of frame. Apply cap head of sealant along void between stop and glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.
 - .16 Structural glazing: Glaze units in accordance with reviewed shop drawings and in accordance with manufacturer's written instructions.
 - .17 Interior glass: Glaze interior glass using glazing gasket glazing tape.
 - .18 Fire rated glass:
 - .1 Install fire rated glass in accordance with ULC and NFPA 80 requirements
 - .2 Place setting blocks located at quarter points of glass with edge block no more than 150 mm from corners.
 - .3 Cut glazing tape to length and set against permanent stops, flush with sight lines to fit openings exactly, with stretch allowance during installation.
 - .4 Glaze vertically into labeled fire-rated metal frames or partition walls with same fire rating as glass and push against tape for full contact at perimeter of pane or unit.
 - .5 Place glazing tape on free perimeter of glazing in same manner described above.
 - .6 Install removable stop and secure without displacement of tape.
 - .7 Install so that appropriate ULC markings remain permanently visible.
 - .19 Balustrade glazing
 - .1 Install glass balustrades to extent, locations, sizes and details shown.
 - .2 Install glass with bottom edge, in pocket to depth minimum 10% of exposed height.
 - .3 Maximum vertical space between ends of glass lights or between ends of glass lights and building walls shall be 20 mm except where shown otherwise.
 - .4 Mount glass rigidly in base pocket to proper spacing, level, alignment and plumb, using silicone setting blocks, shims and dental cement as recommended by manufacturer.
 - .5 Apply thin bead of silicone along top edge of cement.
 - .20 Mirrors:
 - .1 Install mirrors in one single piece in sizes indicated without joints.
 - .2 Set mirrors with adhesive and clips [rosettes], applied in accordance with manufacturer's instructions.
 - .3 Where indicated, provide continuous metal trim along all mirror edges, with mitred corners and concealed fastenings.
 - .21 Install bird warning glass in accordance with City of Toronto Green Development Standard - Bird-Friendly Development Guidelines.
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- .22 Glass film
 - .1 Install glass film with adhesive, applied in accordance with film manufacturer's instructions.
 - .2 Place without air bubbles, creases or visible distortion.
 - .3 Fit tight to glass perimeter with razor cut edge.
- .23 Security film:
 - .1 Install security film with adhesive, applied in accordance with film manufacturer's instructions.
 - .2 Place without air bubbles, creases or visible distortion.
 - .3 Fit tight to glass perimeter with razor cut edge.
 - .4 Apply security sealant from perimeter of glass units in accordance with manufacturers written instructions to achieve specified level of security.

3.4 **CLEANING**

- .1 Immediately remove sealant and compound droppings from finished surfaces.
- .2 Remove labels, protective material, and glass presence markers from prefinished surfaces.
- .3 Clean glass surfaces with cleaning agents and methods in accordance with Manufacturer's written instructions.
- .4 Do not wash glass film for 30 days after installation.
- .5 Do not use bristle brushes on glass film.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for gypsum board work.

1.2 **REFERENCES**

- .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .2 ASTM C475, Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- .3 ASTM C645, Specification for Nonstructural Steel Framing Members.
- .4 ASTM C754, Specification for Steel Framing Members to Receive Screw-Attached Gypsum Board.
- .5 ASTM C834, Standard Specification for Latex Sealants.
- .6 ASTM C840, Specification for Application and Finishing of Gypsum Board.
- .7 ASTM C1002, Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- .8 ASTM C1177, Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
- .9 ASTM C1178, Specification for Glass Mat Water-Resistant Gypsum Backing Board.
- .10 ASTM C1278, Specification for Fiber-Reinforced Gypsum Panel.
- .11 ASTM C1396, Specification for Gypsum Board.
- .12 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.3 **DESIGN REQUIREMENTS**

- .1 Design gypsum board wall and ceiling systems with a maximum deflection of $l/360$.
- .2 Design ceiling suspension system in accordance with manufacturer's printed directions and ASTM C754.
- .3 Design ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

- .4 Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.
- .5 Design suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to allow rotation/relocation of light fixtures.
- .6 Design subframing as necessary to accommodate, and to circumvent, conflicts and interferences where ducts or other equipment prevent the regular spacing of hangers.
- .7 Design wall framing system and reinforce as necessary to accommodate and support items attached to and supported by wall framing system.
- .8 Design wall framing system for wall assemblies with a height greater than 3000 mm and those assemblies incorporating non-standard gypsum board assemblies including, but not limited to, cement/soffit board, large format tile applications, etc.

1.4 **REGULATORY REQUIREMENTS**

- .1 Provide fire separations and fire protection exactly as specified in test design specification that validates the specified rating. Verify that work specified in other Sections, as a part of the entire assembly, meets applicable validating test design specification.

1.5 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop Drawings:
 - .1 Submit Shop Drawings in accordance with Section 01 33 00 indicating:
 - .1 Wall assemblies, suspension systems, adjacent construction, elevations, sections and details, dimensions, thickness, finishes and relationship to adjacent construction.
 - .2 Framing and blocking for items being supported of wall systems.
 - .3 Fire rated designs.
- .3 Certifications: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

1.6 QUALITY ASSURANCE

- .1 Qualifications: Execute the work of this Section by skilled, qualified, and experienced workers trained in the installation of the work of this Section.
- .2 Retain a Professional Engineer, licensed in Province of Ontario, with experience in work of comparable complexity and scope, to perform following services as part of work of this Section:
 - .1 Design of wall systems with height greater than 3000 mm and at non-standard gypsum board assemblies including, but not limited to, assemblies incorporating, exterior soffit board,, large format tile applications, etc.
 - .2 Design of suspended gypsum board assemblies.
 - .3 Review, stamp, and sign Shop Drawings and design calculations.
 - .4 Conduct shop and on-site inspections, prepare and submit written inspection reports verifying that this part of Work is in accordance with Contract Documents and reviewed Shop Drawings.

1.7 SITE CONDITIONS

- .1 Do not begin work of this Section until:
 - .1 Mechanical and electrical work above the ceiling is complete.
 - .2 Substrate and ambient temperature is above 15°C.
 - .3 Relative humidity is below 80 %.
 - .4 Ventilation is adequate to remove excess moisture.
- .2 Install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements 24 h before, during, and 24 h after installation.

2 Products

2.1 MATERIALS

- .1 General: All materials under work of this Section, including but not limited to, sealants, adhesives, and primers are to have low VOC content limits.
- .2 Steel framing: ASTM C754; ASTM A653/A653-M, Z275; cold rolled, galvanized steel sheet.
 - .1 Bailey Metal Products Limited
 - .2 Corus Metal Profiles
- .3 Steel studs and track runners: ASTM C645; Galvanized steel studs and runners, 32 mm wide x depth as indicated on Contract Drawings. Formed from galvanized steel sheet, thicknesses as follows:
 - .1 Studs less than 3000 mm: Minimum 0.53 mm (25 ga.).
 - .2 Studs greater than 3000 mm and non-standard assemblies: Minimum 0.91 mm (20 ga.), unless stud thickness of greater thickness is required to accommodate intended loading, spans, or conditions.

- .3 Track runners and ancillary components to match stud thickness.
- .4 Main carrying channels: ASTM C645; Formed from galvanized steel sheet, 38 x 19 mm cold rolled, channels.
- .5 Resilient channel: ASTM C645; 0.5 mm thick galvanized metal, 57 mm wide x 12 mm deep for walls and ceiling to reduce sound transmission.
- .6 Furring channels: ASTM C645; Formed from galvanized steel sheet, 22 mm winged flange type, cold rolled.
- .7 Furring channels (hat type): ASTM C645; 0.5 mm base steel thickness, galvanized. 70 mm wide x 22 mm deep hat shaped channel.
- .8 Heavy duty furring channels: ASTM C645; 0.9 mm steel thickness, galvanized hat shaped channel with a wider and deeper size as required by manufacturers.
- .9 Hanger wires: 4.1 mm minimum diameter galvanized pencil rod.
- .10 Tie wire: 1.6 mm thick minimum diameter, soft annealed, galvanized steel wire.
- .11 Corner bead, casing bead, and special shapes: Formed from 0.6 mm thick minimum, galvanized steel sheet, designed to be concealed by joint compound.
- .12 Deflection track: ASTM C 645 top runner with 50.8-mm- deep flanges, in thickness indicated for studs and in width to accommodate depth of studs.
- .13 Deflection track (fire rated): Provide 25 mm deep leg deflection track where indicated on rated walls. 'Fire Trak Shadowline' by Fire Trak Corporation or approved alternative.
- .14 Ceiling clips: Hot dip galvanized partition attachment clips, in square and reveal edge; 'PAC 15 Series' to match grid system by CGC Inc. or approved alternative.
- .15 Gaskets (acoustic partitions): Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 3.2 mm thick, in width to suit steel stud size.
- .16 Control joint strip: Roll formed from galvanized steel sheet, with a tape protected recess, 6 mm wide x 11 mm deep.
- .17 Screw fasteners: ASTM C1002 Type S; Corrosion resistant.
- .18 Concrete anchors: tie wire sleeve anchors, 'Redi-Drive Anchors' by ITW Red Head or approved alternative.
- .19 Insulation: In accordance with Section 07 21 00.
- .20 Spray foam Insulation: In accordance with Section 07 21 17.

- .21 Sealants:
 - .1 Acoustic sealant (non-rated): Non-hardening acoustic sealant for use at non-rated assemblies, ASTM C834; Lightweight, acrylic, mould resistant sealant, paintable. 'Lightweight Smoke and Acoustic Sealant CS-S SA Light' by Hilti or approved alternative.
 - .2 Fire-rated sealant: Non-hardening sealant for use at fire-rated assemblies: ASTM E84; Acrylic based firestop sealant, colour: red or white as selected by Consultant. 'Flexible Firestop Sealant CP606' by Hilti or approved alternative.
 - .3 Fire-rated seal: Non-hardening seal for use at fire-rated assemblies: ASTM E84; Flexible seal for installation between top track and substrate. 'Firestop Top Track Seal CFS-TTS' by Hilti or approved alternative.
 - .4 Standard sealants: In accordance with Section 07 92 00.
- .22 Polyethylene vapour retarder: In accordance with Section 07 26 00.
- .23 Vibration isolation ceiling hangers: unit shall consist of a steel spring in series with a neoprene isolating element. Model W30N manufactured by Mason Industries Inc., or approved alternative by PAC International. Provide hangers to ensure that working load does not exceed 2/3 of solid load. Design hangers to tolerate 30 deg. misalignment.
- .24 Gypsum board: ASTM C1396; gypsum board 12.7 mm thick of maximum practical lengths to minimize end joints, unless indicated otherwise. Furnish Board by Certainteed Gypsum Canada, CGC Inc., or Georgia-Pacific Canada LP.
- .25 Fire rated gypsum board (Type X): ASTM C1396; gypsum board 15.9 mm thick of maximum practical lengths to minimize end joints, unless indicated otherwise. Furnish Type X Board by Certainteed Gypsum Canada, CGC Inc., or Georgia-Pacific Canada LP.
- .26 Fire rated gypsum board (Type C): ASTM C1396; gypsum board 12.7 mm thick of gypsum mineral core in maximum practical lengths to minimize end joints, unless indicated otherwise. Type C by Certainteed Gypsum Canada, Firecode C Board by CGC Inc. or approved alternative by Georgia-Pacific Canada LP.
- .27 Cementitious Board: ASTM C1177, high strength portland cement building panel with self adhesive glass tape; provide board with heavier mesh reinforcement for suspended applications. 'Durock Cement Board Next Gen.' by CGC Inc., or approved alternative by Certainteed Gypsum
- .28 Moisture and mould resistant board: 12.7 mm thick of maximum practical lengths to minimize end joints, unless indicated otherwise; 'M2Tech Moisture and Mould Resistant' by Certainteed Gypsum Canada, 'Sheetrock Mold Tough' by CGC Inc. or 'DensArmor Plus High Performance Interior Panel' by Georgia-Pacific Canada LP.

- .29 Tile Backer: Water resistant tile backer board meeting ASTM C1178 or ASTM C1278, thickness as indicated. 'Diamondback Tile Backer' by Certaineed Gypsum Canada, 'Fiberock Aqua-Tough Underlayment' by CGC Inc. or 'Dens Shield' by Georgia-Pacific Canada LP.
- .30 Shaftwall gypsum system:
 - .1 Steel J-Runner: ASTM C645; Rolled formed sheet steel, 25 gauge, by CGC, Gypsum Corporation or approved alternative.
 - .2 C-H stud: hot-dipped galvanized by CGC, Gypsum Corporation or approved alternative.
 - .3 Liner Panel: ASTM C1396; Gypsum wallboard panel, Thickness: 25.4 mm, Width: 610 mm. 'M2Tech Shaftliner Type X' by Certaineed Gypsum Canada, or approved alternative by CGC or Gypsum Corporation.
 - .4 Face Panel: ASTM C1396; Gypsum wallboard panel, 1 layer, Thickness: 15.9 mm, Width: 1219 mm. 'GlasRoc Shaftliner Type X' by Certaineed Gypsum Canada, or approved alternative by CGC or Gypsum Corporation
- .31 Special trim pieces: to include, but not limited to, the following:
 - .1 F reveal: Formed from extruded aluminum alloy 6063 T5. 'FDM-625-75' manufactured by Fry Reglet, Gordon Trims, or approved alternative.
 - .2 L trim: Formed from extruded aluminum alloy 6063 T5. Manufactured by Fry Reglet, Gordon Trims, or approved alternative.
 - .3 J moulding: Formed from extruded aluminum alloy 6063 T5. '1054' manufactured by Fry Reglet, Gordon Trims, or approved alternative.
 - .4 End closure: Formed from extruded aluminum alloy 6063 T5. 'DMEC-200' manufactured by Fry Reglet, Gordon Trims, or approved alternative.
- .32 Primer: Where indicated by board manufacturer, provide primer as required to achieve finishes as defined in ASTM C840.
- .33 Latex Fortified Mortar: Of type recommended by cementitious board manufacturer to suit application.
- .34 Joint reinforcing tape:
 - .1 Standard gypsum board: ASTM C475; 50 mm wide x 0.25 mm thick, perforated paper, with chamfered edges.
 - .2 Moisture resistant and tile backer boards: ASTM C475; fibreglass mat joint tape as recommended by board manufacturer to suit location.
 - .3 Cement Board: Mesh reinforcing tape recommended by cement board manufacturer.
- .35 Bonding adhesive: Type for purpose intended and as recommended and approved by manufacturer.
- .36 Joint and patching compound: ASTM C475; Asbestos-free, supplied by manufacturer of gypsum board used.

- .37 Fast setting patching compound: ASTM C475; Asbestos-free, Sheetrock or Durabond by CGC Inc., 'Moisture and Mold Resistant Setting Compound with M2Tech' by Certainteed Gypsum Canada or approved alternative.
- .38 Access doors: Supplied by other Sections for installation as part of the work of this Section.
- .39 Rubber grommets: 'RB-120' by Spaneur or approved alternative.

3 Execution

3.1 **EXAMINATION**

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

3.2 **SUSPENSION FRAMING**

- .1 Install ceiling systems in accordance with reviewed Shop Drawings and manufacturer's written instructions.
- .2 Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.
- .3 Install vibration isolation hangers at all locations where indicated in strict accordance with manufacturer's printed instructions.
- .4 Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.
- .5 Install additional hangers at lighting fixture and ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.
- .6 Install main carrying channels transverse to structural framing members. Lap main carrying channels 200 mm minimum at splices and wire each end with two loops and prevent clustering or lining-up of splices.
- .7 Install furring channels at 400 mm o.c., not less than 25 mm, and not more than 150 mm from perimeter walls, at openings, at interruptions in ceiling continuity, and at change in plane. Install furring channels to a tolerance of 3 mm maximum in 3600 mm.
- .8 Install additional main carrying and furring channels to frame and to reinforce openings such as recessed lighting fixtures, access hatches, ceiling grilles, outlet boxes, ventilating outlets and similar items.

3.3 STEEL STUDS AND FURRING

- .1 Install steel studs and furring in accordance with reviewed Shop Drawings and manufacturer's written instructions.
- .2 Install steel stud partitions to underside of structure unless indicated otherwise.
- .3 Install track runners at floors, ceilings, and underside of structure; align track runners accurately and secure to structure at 600 mm centres maximum.
- .4 Install double top track runner assembly to prevent the transmission of structural loads to steel studs.
- .5 Install steel studs vertically at 400 mm o.c., unless otherwise indicated, and not more than 50 mm from abutting walls, at openings, and at each side of corners. Install studs securely to track runners.
- .6 Schedule and coordinate steel framing installation with mechanical and electrical services installation.
- .7 Install full height, double studs at door and service openings, fastened together and stiffened back to the structure to prevent vibration when doors close.
- .8 Provide double studs boxed together at all openings, sill, head and jambs and at door jambs, fastened together and stiffened back to the structure to prevent vibration. At each opening exceeding 900 mm in width [or at lead lined door frames], double studs shall be 20 ga. extending to structure above, and adequately anchored at each end. Provide steel studs above and below openings spaced at 400 mm oc maximum. All metal stud partitions above doors and screens over 1220 mm wide shall be secured to structure over and reinforced with sway bracing to stabilize walls to prevent lateral movement.
- .9 Erect three studs at corner and intermediate intersections of partitions. Space 50 mm apart and brace together with wired 19 mm channels.
- .10 Stiffen partitions over 2440 mm high or 3000 mm long, or both, with horizontal bracing extended for full length of partitions. Provide one line of bracing in partitions. Space lines to provide equal unbraced panels. Provide bracing for portions of partitions over door openings in partitions over 3000 mm high, and bracing both above and below openings in partitions located no greater than 150 mm from top and bottom of opening, and extending two stud spaces beyond each edge of opening for both doors and windows. Wire tie or weld bracing to studs.
- .11 Frame control joints using back to back double studs at abutting structural elements, at dissimilar backup interface, at dissimilar walls and ceilings, at structural expansion and control joints, at door and other openings, and at 9000 mm maximum spacing in continuous runs. Install control joint strips and secure in place.

- .12 Install additional support framing at openings and cutouts for built-in equipment, upper cabinet support, access panels and similar items.
- .13 Attach to framing adequate steel reinforcing members or an 1.2 mm (18 ga.) steel stud mounted horizontally and notched around furring members to support the load of, and to withstand the withdrawal and shear forces imposed by, items installed upon the work of this Section. Such items include, but are not restricted to, miscellaneous metals, coat hooks, washroom accessories, handrail anchors, grab bars, guards, wall-hung cabinets and fitments, shelving, miscellaneous specialties; Owner supplied equipment; and minor mechanical and electrical work. Heavy mechanical and electrical equipment shall be self-supporting in Divisions 21, 22, 23 and 26.
- .14 Provide for support and incorporation of flush-mounted and recessed mechanical and electrical equipment and fixtures only after consultation and verification of methods with those performing the work of Divisions 21, 22, 23 and 26.
- .15 Install cross bracing in accordance with the steel stud manufacturer's recommendations.

3.4 **FIRE RATED ASSEMBLIES**

- .1 Install Products in fire rated assemblies in strict accordance with reviewed Shop Drawings and applicable tested and approved designs required by Authorities Having Jurisdiction.
- .2 Install firestop fill material behind fire rated acoustical sealant and provide firestop identification tag.
- .3 Stiffen fire rated walls over 3.66 m high, where linear length of wall is greater than 2.44 m between perpendicular wall supports, with diagonal bracing above the ceiling extending perpendicular to wall at a 45° angle to structure above. Locate diagonal bracing at maximum 2.44 m o.c.
- .4 Where double layers of gypsum board are shown, and required for fire rating, screw first layer to studs and furring and laminate the second layer to the first using joint filler as an adhesive. Stagger joints between first and second layers.

3.5 **INSULATION**

- .1 Install non-rated and fire-rated/acoustic insulation as required for Work of this Project in accordance with Section 07 21 00.
- .2 Install spray foam insulation as required for Work of this Project in accordance with Section 07 21 17.

3.6 **ACOUSTICAL SEALANT**

- .1 Install acoustical sealant to acoustically insulated partitions in accordance with the manufacturer's instructions and Contract Drawings.
- .2 Install acoustical sealant under floor runner track, at partition perimeter both sides and at openings, cut-outs, and penetrations, concealed from view in the final installation.
- .3 Smooth acoustical sealant with trowel prior to skin forming.

3.7 **GYPSUM BOARD**

- .1 Comply with ASTM C840. Install gypsum board in accordance with reviewed Shop Drawings and manufacturer's written instructions.
- .2 Install gypsum board vertically or horizontally, whichever results in fewer end joints. Locate end joints over supporting members.
- .3 Install gypsum board in lightly butted contact at edges and ends and with 1.6 mm maximum open space between boards; do not force gypsum board into place. Do not install imperfect, damaged or damp boards.
- .4 Install gypsum board butting paired tapered edge joints, and mill-cut or field-cut end joints; do not place tapered edges against cut edges or ends.
- .5 Install vertical joints minimum 300 mm from the jamb lines of openings and stagger vertical joints over different studs on opposite sides of partitions.
- .6 Do not locate joints within 200 mm of corners or openings, except where control joints occur at jamb lines or where openings occur adjacent to corners. Where necessary, place a single vertical joint over the centre of wide openings.
- .7 Install gypsum board over concrete and concrete masonry units with adhesive as recommended by gypsum board manufacturer where indicated on Drawings.
- .8 Cut, drill and patch gypsum board as may be necessary to accommodate the work of other trades.
- 9. Fire Separations:
 - .1 Construct gypsum board assemblies, where located, in accordance with tested assemblies to obtain required or indicated fire rated assemblies. As a minimum fire separations shall consist of metal framing covered on both sides by fire-rated gypsum board.
 - .2 Install assemblies tightly to enclosing constructions to maintain integrity of the separations. Install casing beads at all perimeter edges.

3.8 CEMENT BOARD

- .1 Apply cementitious board to framing, with screw fasteners and taped joints in accordance with manufacturers instructions.
- .2 Pre-cut board to required sizes and make necessary cutouts. Fit ends and edges closely but not forced together.
- .3 Fasten board to steel framing with rust proof self-drilling, self-threading case hardened screws at 200 mm oc for walls and 150 mm oc for suspended applications..
- .4 For exterior ceiling/soffit application, staple membrane to back of cementitious board. Extend membrane 75 mm beyond board edges and lap membrane at joints to prevent water penetration into cavity.
- .5 Apply mesh tape centred over all joints and corners but not overlapped.
- .6 Apply 3 mm minimum thick skim coat of latex fortified mortar uniformly over entire cementitious board surfaces. Leave surface smooth and flat to receive subsequent finish.

3.9 SHAFTWALL LINER

- .1 Plan and lay out metal framing components to ensure that all wall sections are plumb and properly aligned.
- .2 Install J-track along the ceiling line and vertically at columns and abutting partitions, positioning the long legs closest to the shaft, using powder actuated fasteners or other approved method. Secure each piece with the appropriate fasteners spaced a maximum 610 mm O.C.
- .3 Attach J-track to the floor with fasteners spaced at 610 mm O.C.
- .4 Install Shaftliner panels vertically. The leading edge of the first panel must be attached to the long leg of the vertical J-track with 41 mm Type S screws spaced 610 mm O.C. Secure the top and bottom edges using the same fasteners and spacing.
- .5 Friction-fit C-H stud into the top and bottom tracks and slide it snugly against the Shaftliner panel. Make sure the edge of the board is in full contact with the centre web of the stud and covered by all the tabs.
- .6 Place the next Shaftliner panel between the tabs and flange on the opposite side of the C-H stud and secure it to the top and bottom track with 41 mm Type S screws spaced 610 mm O.C.
- .7 Install subsequent Shaftliner panels and C-H studs in the same manner. Check periodically to ensure they are plumb.

- .8 At the end of a partition run, cut the last Shaftliner panel slightly narrower and shorter than the opening to facilitate installation.
- .9 For walls exceeding 3.7 m in height, Shaftliner panel end joints shall fall alternately in the upper and lower 1/3 of the partition. Use a C-H stud placed horizontally between panels to secure each joint.
- .10 Frame all cut openings in the shaft side with J-track, providing adequate structural support for openings over 1219 mm.

3.10 **CORNER, CASING BEADS AND TRIM**

- .1 Corner reinforcing bead: Install along all external angles, erect plumb, level and with a minimum of joints. Secure with screws at 225 mm o.c. apply filler over flanges flush with nose of the bead and extending at least 75 mm onto surface of board each side of corner. When filler dries, apply a thin coat of topping cement and blend onto adjoining surfaces.
- .2 Casing bead: Install where wallboard butts against a surface having no trim concealing the juncture and where shown on drawings. Erect casing beads plumb or level, with minimum joints, and secure with screws at 300 mm o.c. apply filler over flange flush with bead and extending at least 75 mm onto surface of board. When dry, apply a thin coat of topping cement and blend onto adjoining surfaces.
- .3 Recess channels and trim: Install recess channels and special metal trim where shown. Secure to substrate. Provide casing beads full height on wallboard edges at recess channels and metal trim.

3.11 **JOINT TAPING AND FINISHING**

- .1 Install reinforcing tape and a minimum of 3 coats of joint compound over gypsum board joints, metal trim and accessories, and screw fasteners in accordance with the gypsum board manufacturer's instructions.
- .2 Fill gaps between ,and any imperfections in, gypsum boards with joint compound, allow to dry, and sand smooth ready for painting.
- .3 Install finished gypsum board work smooth, seamless, plumb, true, flush, and with square, plumb, and neat corners.
- .4 Finish gypsum board in accordance with ASTM C840 to the following grades:
 - .1 Level 0: No taping, finishing, or accessories required. Use above suspended ceilings and within other concealed spaces, unless the assembly is fire rated, sound rated, sound or smoke controlled, or unless the space serves as an air plenum.

- .2 Level 1: At joints and interior angles embed tape in joint compound. Leave surface free of excess joint compound. Tool marks and ridges are acceptable. Use above suspended ceilings and within other concealed spaces if the gypsum board assembly is fire rated, sound rated, sound or smoke controlled, or the space serves as an air plenum.
- .3 Level 2: At joints and interior angles embed tape in joint compound with one separate coat of joint compound applied over joints, angles, fastener heads, and accessories. Use for water resistant gypsum board indicated for use as a substrate for ceramic tile.
- .4 Level 3: At joints and interior angles embed tape in joint compound with two separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges. Use where heavy grade wall coverings are the final decoration.
- .5 Level 4: At joints and interior angles embed tape in joint compound with three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges. Use for all locations except those indicated for other finish levels.
- .6 Level 5: At joints and interior angles embed tape in joint compound with three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply a thin skim coat of joint compound, or a material manufactured especially for this purpose, to the entire surface. Leave surface smooth and free of tool marks and ridges. Use where semi-gloss or gloss finish coatings are the final decoration.

3.12 ACCESS DOORS

- .1 Install access doors, supplied as part of other parts of the work, in accordance with manufacturer's written instructions.

3.13 SITE TOLERANCES

- .1 Install metal support systems to ensure that, within a tolerance of +3 mm and -1.5 mm for plaster thickness, finish surfaces will be flat within 3 mm under a 3 m straightedge, and with no variation greater than 1.5 mm in any running 300 mm, and that surface planes shall be within 3 mm of dimensioned location.

3.14 REPAIR

- .1 Make good cut-outs for services and other work, fill in defective joints, holes and other depressions with joint compound.
- .2 Make good defective work, and ensure that surfaces are smooth, evenly textured and within specified tolerances to receive finish treatments.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

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

1.2 **REFERENCES**

- .1 ANSI A108/A118/A136.1, Installation of Ceramic Tile.
- .2 ANSI A137.1, Specifications for Ceramic Tile.
- .3 ASTM C144, Specification for Aggregate for Masonry Mortar.
- .4 ASTM C920, Specification for Elastomeric Joint Sealants.
- .5 CAN/CSA A3000, Cementitious Materials Compendium.
- .6 TTMAC Specification Guide 09 30 00 Tile Installation Manual.
- .7 TTMAC, Maintenance Guide.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations and warranties.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Tile layout, patterns, and colour arrangement.
 - .2 Perimeter conditions, junctions with dissimilar materials.
 - .3 Setting details.
- .3 Samples:
 - .1 Submit following sample panels in accordance with Section 01 33 00.
 - .1 Each colour, texture, size, and pattern of tile.
 - .2 Adhere tile samples to 400 x 400 x 12.5 mm thick cement board complete with selected grout colour in joints.
- .4 Certificates: Submit manufacturer's certificates stating that materials supplied are in accordance with this specification.

- .5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.
- .6 Closeout submittals: Submit recommended maintenance instructions and listing of recommended maintenance Products for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.4 **QUALITY ASSURANCE**

- .1 Perform work of this Section by a company that is a member in good standing of the Terrazzo Tile and Marble Association of Canada with proven, acceptable experience on installations of similar complexity and scope.

1.5 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver materials in adequate crates or containers with manufacturer's name and product description clearly marked.
- .2 Handle and store tiles in a manner to avoid chipping, breakage or the instruction of foreign matter. Take precautions to protect the mortar and grout admixtures from freezing or from excessive heat.

1.6 **SITE CONDITIONS**

- .1 Do not install work of this Section outside of the following environmental ranges without the Consultant's and Product manufacturer's written acceptance:
 - .1 Ambient air and surface temperature: 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.

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 ANSI A137.1.
 - .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 Tiles to be of the same batch to ensure consistency in tile sizes.
 - .5 Tile (CT.1, CT.2, CT.3): Porcelain and ceramic tile, size and finish of floor and wall tiles to be selected by Consultant.
- .3 Tile Base: Cove base tile to match floor tile.
- .4 Thresholds: Match floor tile, full width of door openings, at junction of ceramic tile and carpet and resilient floor materials.
- .5 Floor 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.
- .6 Wall edge protection: Aluminum edge protection with trapezoid-perforated anchoring leg and an anodized finish, continuous at all exposed tile edges, depth as required to suit tile thickness. 'Jolly' by Schluter Systems or approved alternative.

2.2 ACCESSORIES

- .1 Cement: CAN/CSA A3000, Type GU.
- .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: 'Mortar Admix' by Custom Building Products, 'Keralastic' by Mapei Inc or approved alternative by Ardex, Flextile Ltd. or Laticrete International.
- .5 Thin-set mortar: 2 component to ANSI A108/A118/A136.1:
 - .1 'Ardex X77 Microtec' by Ardex, 'Porcelain Tile Fortified Thin-Set Mortar' by Custom Building Products, '56SR/51 w/44' by Flextile Ltd., '254/255' by Laticrete International or 'Kerabond with Keralastic Latex Additive' by Mapei Inc.
 - .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 Medium bed mortar: to ANSI A118.4:
 - .1 'Natural Stone & Large Tile Premium Mortar' by Custom Building Products, '220 Marble & Granite' by Laticrete International Inc., 'Ultraflex LFT' by Mapei Inc., or approved alternative by Ardex.
 - .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.

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- .7 Thick bed sloped topping: Factory mixed blend of portland cement and aggregates with latex admix. 'Ardex X32 Microtec' by Ardex, '226 thick bed mortar with 3701 admix' by Laticrete, 'Topcem with Planicrete AC Admixture' by Mapei Inc., or approved alternative by Custom Building Products.
 - .8 Primer: To meet specified requirements of adhesive manufacturer.
 - .9 Cleaner: In accordance with TTMAC's requirements and as recommended by tile manufacturer.
 - .10 Crack-isolation system: Flexible, thin, fabric-reinforced, peel and stick membrane meeting ANSI A118.12 cut into strips to suit joints. 'Crack Buster Pro' by Custom Building Products, 'Fracture Ban' by Laticrete International Inc., 'Mapeguard 2' by Mapei Inc., or approved alternative by Ardex. Provide manufacturer approved primer.
 - .11 Waterproof Membrane Two-component, cement-based, fibre-reinforced waterproofing membrane. 'Mapelastic 315' by Mapei or 'RedGard Waterproofing and Crack Prevention Membrane' by Custom Building Products, or Laticrete International Inc.
 - .12 Grout:
 - .1 Floors and bases (below 3 mm joint width): 'Polyblend Non-Sanded' by Custom Building Products, '1600 Non-Sanded' by Laticrete International, 'Keracolor U' by Mapei Inc. or approved alternative by Ardex, or Flextile Ltd.
 - .2 Floors and bases (3 mm to 10 mm joint width): 'Prism Ultimate Performance' by Custom Building Products, 'Permacolor' by Laticrete International, 'UltraColor Plus' by Mapei Inc. or approved alternative by Ardex, or Flextile Ltd.
 - .3 Walls (1.5 mm to 3 mm joint width): 'Polyblend Non-Sanded' by Custom Building Products, '1600 Non-Sanded' by Laticrete International, 'Keracolor U' by Mapei Inc. or approved alternative by Ardex, or Flextile Ltd.
 - .4 Walls (over 3 mm joint width): 'Prism Ultimate Performance' by Custom Building Products, 'Permacolor' by Laticrete International, 'UltraColor Plus' by Mapei Inc. or approved alternative by Ardex, or Flextile Ltd.
 - .5 Grout colour: To be selected by the Consultant from the manufacturer's full colour range.
 - .13 Tile sealant: In accordance with Section 07 92 00.

2.3 MIXES

- .1 Levelling bed mix:
 - .1 1 part Portland cement.
 - .2 4 parts sand.
 - .3 1 part water (including polymer additive), adjusted for water content of sand.
 - .4 1/10 part polymer additive.

3 Execution

3.1 **EXAMINATION**

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

3.2 **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.

3.3 **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.

3.4 **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.

3.5 CRACK ISOLATION

- .1 Apply crack-isolation system over shrinkage and non-structural hairline cracks and "spiderwebbing" cracks in structural concrete floor slabs or in concrete topping on structural concrete floor slabs.
- .2 Apply liberal coat of primer with brush or roller over cracks, slightly wider than width of membrane. Roll out enough membrane to cover crack; cut and imbed while liquid is wet. Roll membrane to ensure adhesion.

3.6 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.

3.7 GENERAL INSTALLATION REQUIREMENTS

- .1 Install tiles in accordance with manufacturer's instructions and TTMAC Specification Guide 09 30 00 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 98% for large format (305 mm x 305 mm or greater) interior applications.
 - .2 90% for non-large format interior applications.
- .6 Adjust joints between units uniform, plumb, straight, even, and true, with adjacent tile flush. Align grout joints in both directions unless indicated otherwise.
- .7 Align floor, 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.

3.8 **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 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.

3.9 **JOINT BACKING AND TILE SEALANT**

- .1 Install joint backing and sealant in accordance with Section 07 92 00.

3.10 **PROTECTION**

- .1 Prevent traffic over tiled areas, and protect tiled assemblies from weather, freezing, and water immersion, for 72 hours minimum, after final installation.
- .2 Prevent direct impact, vibration and heavy hammering on adjacent and opposite walls for 24 hours minimum, after final installation.
- .3 Cover work temporarily with building paper properly lapped and taped at joints until work has been approved by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for tactile walking surface indicator work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM C1028, Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
- .2 ISO 23599, Assistive Products for Blind and Vision-Impaired Persons - Tactile Walking Surface Indicators.
- .3 CAN/ULC S102.2, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.

1.3 **DESIGN REQUIREMENTS**

- .1 Design detectable tile system conforming to ISO 23599.

1.4 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations and warranties.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Perimeter conditions, junctions with dissimilar materials.
 - .2 Setting details.
- .3 Samples: Submit two 300 x 300 mm samples of each type of detectable/tactile warning surfaces in accordance with Section 01 33 00.
- .4 Closeout submittals: Submit recommended maintenance instructions and listing of recommended maintenance Products for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.5 QUALITY ASSURANCE

- .1 Mock-up:
 - .1 Construct full mock-up of each detectable tactile tile systems in location acceptable to Consultant.
 - .2 Construct full mock-up of each detectable tactile tile systems including installation adjacent to each floor materials in location acceptable to Consultant.
 - .3 Demonstrate colour disbursement and finishing.
 - .4 Arrange for Consultant's review and acceptance.
 - .5 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.
 - .6 Upon acceptance, mock-up shall serve as

1.6 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 or breakage. Take precautions to protect the adhesives from freezing or from excessive heat.

1.7 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: Minimum 40°F.
 - .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.

1.8 MAINTENANCE

- .1 Submit extra tile amounting to 3% of gross area covered, allowing proportionately for each pattern and type specified and which are part of the same Production run as installed Products. Store maintenance Products as directed by the Consultant.

2 Products

2.1 MATERIALS

- .1 All materials under work of this Section, including but not limited to, sealants and adhesives are to have low VOC content limits.

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- .2 Tactile Walking Surface Indicator (TWSI):
 - .1 Conforming to ISO 23599 and meeting AODA Requirements.
 - .2 Dome: Clear aluminum finish containing truncated domes with a top dome diameter of 23 mm and a dome height of 5 mm, domes to be spaced out at 60 mm. 'UAS-AL2218' by Urban Access Solutions or approved alternative.
 - .3 Colours: Refer to Interior Finishes Materials Schedule.
 - .4 Adhesive: Bonding adhesive as approved by tactile tile manufacturer.
 - .3 Wayfinding Tile (TWFT):
 - .1 Conforming to ISO 23599 and meeting AODA Requirements.
 - .2 Strips: 300 x 300 x 10 mm thick porcelain tile containing wayfinding bars with a top dome diameter of 17 mm and a dome height of 4 mm, domes to be spaced out at 75 mm. 'ELAN-B-1212' by Kinesik Engineered Products or approved alternative.
 - .3 Colours: Refer to Interior Finishes Materials Schedule.
 - .4 Coordinate with Landscape Consultant and Landscape Drawings.
 - .5 Adhesive: Bonding adhesive as approved by tactile tile manufacturer.
 - .4 Fasteners: Colour matched, corrosion resistant, flat head drive anchor as recommended by tile Manufacturer.
- 3 Execution
- 3.1 **EXAMINATION**
- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- 3.2 **PREPARATION**
- .1 Prepare substrate using steel aggregate blast method and vacuum substrate free of debris and dust.
 - .2 Fill minor cracks and voids and prime surfaces in accordance with manufacturer's recommendations.
 - .3 Project adjacent surfaces from damage resulting from this work. Mask and/or cover adjacent surfaces, fixtures, and equipment as necessary.
 - .4 Clean, prime and seal surfaces as recommended by detectable tile manufacturer.
- 3.3 **SURFACE APPLIED INSTALLATION**
- .1 Apply adhesive to backside of tile, following perimeter and internal cross pattern established by tile manufacturer. Ensure sufficient adhesive has been placed on prescribed areas to have full coverage across width of adhesive locator and shall be applied to within 6 mm continuously around perimeter edge of tile.
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- .2 Set tile true and square to areas as detailed on drawings.
- .3 Working from centre of tile outwards, proceed to drill and install all fasteners in tile's moulded recesses.
- .4 Drill hole while standing with both feet applying pressure around moulded recess in tile, drill through tile without hammer option until tile has been penetrated, then with hammer option to drill into concrete. Maintain foot pressure on both sides of hole while drilling to prevent concrete dust from accumulating between tile and concrete.
- .5 Immediately after drilling each hole, mechanically fasten tile to concrete substrate while still applying foot pressure. Ensure fastener has been placed to full depth in dome, straight, and flush to the top of dome and drive pin of fastener with mallet.
- .6 Apply perimeter caulking sealant in accordance with sealant manufacturer's recommendations and Section 07 92 00.

3.4 STAIR INSTALLATION

- .1 Install tactile indicator and wayfinding bar tiles at top and bottom of stair in accordance with manufacturers written instructions using adhesive and fasteners and to conform to standards.
- .2 Install tactile indicator and wayfinding bar at tiles at top and bottom of stair and layouts as per Architecture Drawings and details. Coordinate with Landscape Consultant and Landscape Drawings.
- .3 Set tile true and square to areas as detailed on drawings.

3.5 CLEANING AND PROTECTION

- .1 Clean tiles in accordance with manufacturer's written instructions.
- .2 Prevent traffic over new installed detectable tiles, and protect from weather, freezing, and water immersion, for 24 hours minimum, after final installation.
- .3 Cover work temporarily with plywood until work has been approved by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for acoustical ceiling tiles work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .2 ASTM C423, Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- .3 ASTM C635, Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- .4 ASTM C636, Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
- .5 ASTM C645, Specification for Non-Load Bearing (Axial) Steel Studs, Runners (Tracks), and Rigid Furring Channels for Screw Application of Gypsum Board.
- .6 ASTM C665, Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- .7 ASTM E1264, Classification for Acoustical Ceiling Products.

1.3 **DESIGN REQUIREMENTS**

- .1 Design acoustical ceiling tile system in accordance with following Climatic Design Data for Toronto 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 ceiling suspension systems in accordance with ASTM C636 and manufacturer's printed directions.
- .3 Design tile ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority. Acoustic panel system is not designed to carry the weight of electrical equipment.
- .4 Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.
- .5 Design tile suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to allow rotation/relocation of light fixtures. Acoustic panel system is not designed to carry the weight of mechanical and electrical equipment.

- .6 Design subframing as necessary to accommodate, to avoid conflicts and interferences where ducts or equipment prevent regular spacing of hangers.

1.4 SUBMITTALS

- .1 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Suspension system layout including hangers and supports for acoustic tile system.
 - .2 Acoustic panel system including suspension system, hangers, supports and panel sizes and locations.
 - .3 Conditions at abutting, intersecting, and penetrating construction.
 - .4 Dimensioned locations of lighting fixtures, diffusers, sprinkler heads and other items that pierce the ceiling plane.
- .2 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00:
 - .1 One full-size sample of each type of tile panels to be used.
 - .2 One of each type of suspension system members.
- .3 Certificates: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

1.5 QUALITY ASSURANCE

- .1 Mock-up:
 - .1 Construct one 3 m² mock-up for each type of ceiling and tile system incorporating typical light fixture and other typical mechanical and electrical fixtures.
 - .2 Test the adequacy of the suspension system to support the fixtures without deflection of ceiling or failure of hanging wire anchorage. Supply copy of Test Results to Consultant.
 - .3 Change materials and installation methods if tests indicate proposed system is inadequate and re-test as necessary until system approved.
 - .4 Give early notice to Consultant and Mechanical and Electrical Trades and co-operate with them in selecting suitable location for sample ceiling and timing of installation and test.
 - .5 Do not commence general installation work until sample ceiling approved, then install ceiling to conform with approved samples.
 - .6 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

1.6 **SITE CONDITIONS**

- .1 Do not install the work of this Section until:
 - .1 Mechanical and electrical work above the ceiling is complete.
 - .2 Relative humidity is below 80 %.
 - .3 Ventilation is adequate to remove excess moisture.
 - .4 Areas are closed and protected against weather, and maintained at no less than 10°C.
- .2 Install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements 24 h before, during, and after installation.

1.7 **MAINTENANCE**

- .1 Submit extra acoustic ceilings amounting to 2% of gross ceiling area, allowing proportionately for each pattern and type specified to nearest full carton. Submit Products which are part of same production run as installed Products. Store maintenance Products as directed by Consultant.

1.8 **DELIVERY, STORAGE AND HANDLING**

- .1 Transport, handle and store material in manner to prevent warp, twist, damage to panel edges and surfaces in accordance with Manufacturer's recommendations.
- .2 Any warped and/or damaged panels and trim shall be rejected and be replaced by new, straight, undamaged and acceptable material at no cost to Owner.
- .3 Bent, twisted or otherwise damaged Tee grid suspension components shall not be used under any circumstances. Replace such damaged items with new undamaged material at no additional cost to Owner.
- .4 Store material in warm, dry place away from water and the elements. Protect against undue loading stresses and shock.
- .5 All packaged material shall be delivered in original manufacturers wrappers and containers with labels and seals intact. All cartons shall bear U.L. label.

2 Products

2.1 **MATERIALS**

- .1 Galvanized steel sheet: ASTM A653/A653-M, Z275; cold rolled, galvanized steel sheet.
- .2 Main carrying channels: ASTM C645; Channels formed from galvanized steel sheet, 38 x 19 mm cold rolled.
- .3 Subframing: ASTM C645; Channels formed from galvanized steel sheet, dimensions and spans as required.
- .4 Hangers: 2.6 mm minimum diameter, galvanized steel wire.

- .5 Tie wire: 1.6 mm minimum diameter, soft annealed galvanized steel wire.
- .6 Concrete anchors: tie wire sleeve anchors, 'Redi-Drive Anchors' by ITW Red Head or approved alternative.
- .7 Wall mouldings and accessories, including but not limited to, corner caps, edge mouldings, panel hold over clip, metal closures, and trim. Finish and colour: same as main tees.
- .8 Exposed main, cross tees, and relocatable cross tees: ASTM C635, 38 mm high steel, bulb tee design double steel web, rectangular single spans without exceeding a deflection of 1/360 of the span. Splices to be integral and reversible; cross tee interlocking into main tee. Colour and finish: Manufacturer's standard white.
 - .1 Suspension system manufacturers:
 - .1 Armstrong World Industries Inc.
 - .2 CGC Inc.
 - .3 Certainteed Ceilings Canada.
 - .4 Rockfon/Chicago Metallic.
- .9 Acoustic tile (ACT.1): ASTM E1264, type A, Form A2.2, Pattern E; Fire Class A, NRC: 0.80, Wet-formed mineral fibre with acoustically transparent membrane and scrim with factory applied latex paint., square lay-in, 'Ultima High NRC' by Armstrong Ceiling Tiles or approved alternative by CGC Inc.
- .10 Wall mouldings: To match acoustical ceiling suspension system.

3 Execution

3.1 EXAMINATION

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

3.2 SUSPENSION SYSTEM

- .1 Coordinate locations and openings of mechanical and electrical services support, and penetration through the acoustical ceilings. Coordinate field conditions, clearances, measurements, and mechanical and electrical services testing and commissioning, above the acoustical ceilings.
- .2 Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.
- .3 Install acoustical ceiling systems in accordance with manufacturer's written instructions, reviewed shop drawings, and ASTM C636, listed in order of precedence.

- .4 Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.
- .5 Install additional hangers at lighting fixture and air distribution ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.
- .6 Install acoustical ceiling suspension system to a tolerance of 1:1200 of span and 0.4 mm maximum between adjacent metal members. Tolerances are not cumulative. Refer to Electrical Contract Drawings for fixture layout.
- .7 Do not bend or twist hangers as a means of levelling. Form double loops tightly and lock to prevent vertical movement or rotation within the loop.
- .8 Install edge moulding at intersection of ceiling and vertical surfaces.
- .9 Centre acoustical ceiling suspension systems on room axis; install equal border pieces. Install hangers onto the ends of main tee runners at not more than 150 mm from ends of runners, adjacent and perpendicular to walls.
- .10 Support the suspension system independently of walls, columns, ducts, pipes and conduits.
- .11 Install main runners in maximum available lengths. Layout joints in suspension members to avoid the perimeters of recessed fixtures. Lock grid members to form a rigid assembly. Install additional tee, suspension system framing around recessed fixtures, diffusers, grilles and other items for a complete assembly.

3.3 ACOUSTIC LAY-IN TILES

- .1 Install acoustic tile in grid system openings supported by bottom flanges of members. Provide special shapes and sizes to provide a complete installation by cutting tile to fit into openings. Fit tile moderately tight between upright legs of members.
- .2 Carefully cut and trim acoustic tiles to accommodate items piercing the finished ceiling plane.
- .3 Remove and replace acoustic tiles with broken edges, or damaged, marked, discoloured, soiled, or stained faces.

3.4 ADJUSTMENTS AND CLEANING

- .1 Clean soiled or discoloured surfaces of exposed work on completion of work.
- .2 Replace components which are visibly damaged, marred or uncleanable.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for interior wood ceiling and wall panel work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .2 ASTM C635, Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- .3 ASTM C636, Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
- .4 ASTM C645, Specification for Non-Load Bearing (Axial) Steel Studs, Runners (Tracks), and Rigid Furring Channels for Screw Application of Gypsum Board.

1.3 **DESIGN REQUIREMENTS**

- .1 Design ceiling suspension system in accordance with ASTM C636 and manufacturer's printed directions.
- .2 Design ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.
- .3 Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.
- .4 Design suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to allow rotation / relocation of light fixtures.
- .5 Design subframing as necessary to accommodate, to avoid conflicts and interferences where ducts or equipment prevent regular spacing of hangers.

1.4 **SUBMITTALS**

- .1 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Suspension system layout including hangers and isolators.
 - .2 Conditions at abutting, intersecting, and penetrating construction.
 - .3 Dimensioned locations of lighting fixtures, diffusers, sprinkler heads and other items that pierce the ceiling plane.

- .2 Certificates: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

1.5 **QUALITY ASSURANCE**

- .1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of wood ceilings of a similar size and nature and that is approved by manufacturer. Submit to Consultant, installer's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Mock-up:
 - .1 Construct one 2 m² mock-up of wood ceilings and wall in location acceptable to Consultant.
 - .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
 - .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
 - .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

1.6 **SITE CONDITIONS**

- .1 Do not install the work of this Section until:
 - .1 Mechanical and electrical work above the ceiling is complete.
 - .2 Relative humidity is below 80 %.
 - .3 Ventilation is adequate to remove excess moisture.
- .2 Install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements 24 h before, during, and after installation.

2 **Products**

2.1 **MATERIALS**

- .1 Galvanized steel sheet: ASTM A653/A653-M, Z275; cold rolled, galvanized steel sheet.
- .2 Main carrying channels: ASTM C645; Channels formed from galvanized steel sheet, 38 x 19 mm cold rolled.
- .3 Subframing: ASTM C645; Channels formed from galvanized steel sheet, dimensions and spans as required.
- .4 Hangers: 2.6 mm minimum diameter, galvanized steel wire.
- .5 Tie wire: 1.6 mm minimum diameter, soft annealed galvanized steel wire.

- .6 Exposed main, cross tees, and relocatable cross tees: 25 mm exposed face x 38 mm high steel, bulb tee design double steel web, rectangular single spans without exceeding a deflection of 1/360 of the span. Splices to be integral and reversible; cross tee interlocking into main tee. Colour and finish: Matte black.
- .7 Suspension system: ASTM C635; 'Donn DX Fast-Loc' by CGC Inc. or approved alternative by Armstrong World Industries Inc.
- .8 Furring channels: ASTM C645; Formed from galvanized steel sheet, 22 mm winged flange type, cold rolled.
- .9 Snap-on clip: manufacturer's standard snap on clip.
- .10 Linear Wood ceiling panels:
 - .1 Wood ceiling planks:
 - .1 Class A rated to ASTM E84 or CAN/ULC-S102, wood planks fabricated from fire rated moisture resistant MDF core and Douglas Fir veneer, with quarter cut finish.
 - .2 Planks sized at 19 mm x 133 mm, minimum length 3020 mm, square edge profile.
 - .3 Shop finished: Manufacturer's standard clear finish, exterior grade and suitable for pool environment, with a gloss sheen of 10 and to match Consultant approved samples.
 - .2 Backer:
 - .1 19 mm x 38 mm, hardwood backer, predrilled for concealed fastening to planks.
 - .2 Finish: Field painted black in accordance with Section 09 91 00.
 - .3 Installation kit: Provide manufacturer's standard site finishing/installation kit for final site finishing of site cut edges, matching trim veneers and touch-up work for minor repairs, to match specified system and provide a seamless and matching appearance.
 - .4 Acceptable manufacturers: Linear wood plank ceiling by CertainTeed Architectural or approved alternative.
- .11 Wood ceiling system:
 - .1 Class A rated to ASTM E84 and CAN/ULC-S102, interior acoustic wood veneered panel with book-matched, plain sliced white oak veneer species, prefinished with a UV stable, varnish system with a matte finish, having square edges, hairline reveals and complete with trims.
 - .2 Face veneer: Minimum 0.6 mm thick real wood veneer, Quality AA.
 - .3 Back veneer: Blind veneer and manufacturer's standard black acoustic fleece.
 - .4 Acoustic insulation: Acoustic batt infill in accordance with Section 07 21 00 and as required to meet intended NRC rating.
 - .5 Interior wood system: Manufacture by Armstrong or approved alternative.

- .12 Wood wall system:
 - .1 Class A rated to ASTM E84 and CAN/ULC-S102, micro-perforated wood veneered panel with book-matched, plain sliced white oak veneer species, prefinished with a UV stable, varnish system with a matte finish, having square edges, hairline reveals and complete with trims.
 - .2 Perforation size: to be selected by Consultant.
 - .3 Face veneer: Minimum 0.6 mm thick real wood veneer, Quality AA.
 - .4 Back veneer: Blind veneer and manufacturer's standard black acoustic fleece.
 - .5 Acoustic insulation: Acoustic batt infill in accordance with Section 07 21 00 and as required to meet intended NRC rating.
 - .6 Interior wood system: Manufacture by Armstrong or approved alternative

3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

- .1 Install wood ceiling and wall assemblies, support and anchoring system, fasteners, trim and related items to lines and elevations indicated and in strict accordance with reviewed shop/erection drawings and manufacturer's printed instructions. Carefully coordinate work with other Sections.

3.3 SUSPENSION SYSTEM

- .1 Coordinate locations and openings of mechanical and electrical services support, and penetration through the ceiling system. Coordinate field conditions, clearances, measurements, and mechanical and electrical services testing and commissioning, above ceiling.
- .2 Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.
- .3 Install ceiling systems in accordance with manufacturer's written instructions, reviewed shop drawings, and ASTM C636, listed in order of precedence.
- .4 Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.
- .5 Install additional hangers at lighting fixture and air distribution ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.

- .6 Install ceiling suspension system to a tolerance of 1:1200 of span and 0.4 mm maximum between adjacent metal members. Tolerances are not cumulative. Refer to Electrical Contract Drawings for fixture layout.
- .7 Do not bend or twist hangers as a means of levelling. Form double loops tightly and lock to prevent vertical movement or rotation within the loop.
- .8 Support the suspension system independently of walls, columns, ducts, pipes and conduits.
- .9 Install main runners in maximum available lengths. Layout joints in suspension members to avoid the perimeters of recessed fixtures. Lock grid members to form a rigid assembly. Install additional tee, suspension system framing around recessed fixtures, diffusers, grilles and other items for a complete assembly.
- .10 Install wood ceiling panels attach to grid system with snap-on spring clips. The clips are placed under the dowel or backer support and attach to the suspension system above.
- .11 Inspect and adjust wood ceiling panels to insure their proper location and attachment to suspension system are correct according to manufacturer's recommendations and practices.
- .12 Clean and touch up any exposed wood ceilings with matching finish provided by manufacturer.

3.2 **WOOD PANELS**

- .13 Install wood panels in accordance with reviewed shop drawings and manufacturer's written instructions.
- .14 Attach wood panels attach to soffit grid system or furring system with clips and fasteners as required.
- .15 Install with undamaged edges and fitted accurately to suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit, as required.
- .16 Furring (wall applications): Install support system true and plumb in order to provide proper support for wood panels.
- .17 Damaged panels, waviness, warp or distortion of finished work will not be accepted.
- .18 Cover field cut edges by means of trims.
- .19 Ensure final installation of wood panels is secure, level and rigid and free from rattling and noise.

3.4 FIELD QUALITY CONTROL

- .1 Arrange, pay for, and execute Site load tests at location selected by Consultant, on anchor inserts by an independent, certified testing company. Perform 10 random anchor tests at commencement of work. Pay for additional tests, required if pull out strength is not acceptable as requested by Consultant.

3.2 ADJUSTMENT AND CLEANING

- .2 Inspect and adjust wood ceiling and wall panels to ensure their proper location and attachment to suspension systems is correct according to manufacturer's recommendations and practices.
- .3 Clean and touch up any exposed wood ceiling and wall panel assemblies with matching finish provided by manufacturer and to the satisfaction of the Consultant.

3.5 PROTECTION

- .1 Protect installed work from damage due to subsequent construction activity, including temperature and humidity limitations and dust control, so that the work will be without damage and deterioration at the time of acceptance by the Owner.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for resilient base work and accessories in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM F1861, Specification for Resilient Wall Base.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Samples: Submit two 250 mm long samples of resilient base in accordance with Section 01 33 00.
 - .3 Closeout submittals: Submit maintenance and cleaning data for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.4 **SITE CONDITIONS**

- .1 Maintain air temperature and structural base temperature at installation area above 20°C for 48 hr before, during and 48 hr after installation.
- .2 Store materials for 2 days prior to installation in area of work to achieve temperature stability.
- .3 Do not install base in conditions of high humidity or where exposed to cold drafts. In hot weather, protect from direct sunlight.
- .4 Provide adequate ventilation during installation.

1.5 **MAINTENANCE**

- .1 Submit extra 5% or to nearest full roll of each colour, pattern and type of base required for maintenance use. Identify each carton. Store where directed.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers, and adhesives are to have low VOC content limits.
- .2 Rubber base (RB): ASTM F1861, Type TP, Group 1, rubber wall base, approximately 100 mm high x 6 mm thick toeless profile, in lengths as long as possible including premoulded end stops and inner and outer corners. Colours: Refer to Interior Finishes Schedule. 'Monument Series' by Tarkett or approved alternative.
- .3 Metal trims and caps: Metal trims with trapezoid anchoring leg by Schluter or approved alternative.
- .4 Reducing edge strips, transition strips, thresholds and accessories: To be selected by Consultant.
- .5 Primers and adhesives: Low VOC, waterproof, recommended by base manufacturer for specific material on applicable substrate, above, at or below grade.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Defective work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the work of this Section.

3.2 **RESILIENT BASE APPLICATION**

- .1 Install resilient base in accordance with manufacturer's written instructions.
- .2 Lay out base to keep number of joints at minimum.
- .3 Prior to installing base, fill cracks and irregularities with a filler recommended by base manufacturer.
- .4 Set base in adhesive using a 3 kg hand roller, against wall and floor surfaces.
- .5 Install straight and level to variation of 1:1000.
- .6 Scribe and fit to door frames and other obstructions.
- .7 Cope internal corners.

3.3 CLEANING

- .1 Forty-eight hours after installation, clean resilient base surfaces with a mild soap solution approved by finish manufacturer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for resilient sheet flooring work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM F710, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- .2 ASTM F1516, Standard Practice for Sealing Seams of Resilient Floor Products by the Heat Weld Method.
- .3 ASTM F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- .4 ASTM F2170, Standard Test Method for Determining Relative Humidity in Concrete Slabs Using in-situ Probes.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings: Submit shop drawings indicating seam layout and welding procedures in accordance with Section 01 33 00.
- .3 Samples:
 - .1 Submit samples in accordance with Section 01 33 00:
 - .1 Two 250 x 200 mm samples of each type of sheet material and colour.
 - .2 Two 250 mm long samples of each accessory and colour.
- .4 Extended warranties: Submit extended warranties signed and registered by the manufacturer providing the warranties in the name of the Owner for the timeframe and coverage specified in this Section.
- .5 Closeout submittals: Submit maintenance and cleaning data for incorporating into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.4 **SITE CONDITIONS**

- .1 Maintain air temperature and structural base temperature at flooring installation area above 20°C for 48 hr before, during and 48 hr after installation.
- .2 Store materials for two (2) days prior to installation in area of Work to achieve temperature stability.
- .3 Do not lay flooring in conditions of high humidity or where exposed to cold drafts. In hot weather, protect from direct sunlight.
- .4 Provide adequate ventilation during installation.

1.5 **EXTENDED WARRANTY**

- .1 Manufacturer's warranty:
 - .1 Resilient flooring: Provide flooring manufacturer's warranty naming Owner as beneficiary, covering excessive wear for a period of five (5) years from the date Work is certified as Substantially Performed.

1.6 **MAINTENANCE**

- .1 Submit extra 5% or to nearest full roll of each colour, pattern and type of flooring material required for maintenance use. Identify each roll. Store where directed. Submit maintenance material in one piece and of same production run as installed materials.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers and adhesives are to have low VOC content limits.
- .2 Sheet vinyl flooring (SV.1): ASTM F1303; Type 1, Grade 1, Class B Backing, Thickness: 2 mm. Finish: To be selected by the Consultant. Acceptable material: To be selected by the Consultant.
- .3 Base and accessories: In accordance with Section 09 65 19.
- .4 Welding rod: type recommended by flooring manufacturer to complement flooring.
- .5 Primers and adhesives: Low VOC, waterproof, of types recommended by flooring manufacturer for specific material on applicable substrate, above, on or below grade.
- .6 Reducing edge strips, thresholds: Nitrile rubber plasticized vinyl, 80-95 Shore A Durometer, adhesive as recommended by manufacturer.

- .7 Concrete skim coat compound: High-performance, rapid-setting cement based skim coating compound. 'Ultra SkimCoat' by Mapei or approved equivalent for filling minor voids and leveling existing substrate.
- .8 Stain sealer and polish: Type recommended by flooring manufacturer.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Ensure concrete floors meet the following minimum requirements and requirements of the flooring manufacturer. If there is a conflict between these requirements and those of the flooring manufacturer, the more stringent shall apply.
 - .1 Internal Relative Humidity Test: Perform internal relative humidity testing in accordance with ASTM F2170. Results shall not exceed 80% RH.
 - .2 Moisture Test: Moisture emissions from concrete subfloors (cured for a minimum of 28 days) must not exceed 3 lbs per 1000sf per 24 hours (1.4 kg H₂O/24 hr/93 m²) for acrylic adhesive and 5lbs for polyurethane adhesive via the Calcium Chloride Test Method (ASTM F1869).
 - .3 The pH level of the subfloor surface shall not be higher than 9.9. If higher, subfloor must be neutralized.
- .3 Ensure that sub-floors have been provided as specified without holes, protrusions, cracks, depressions or other major defects.
- .4 Ensure that control joints have been filled and levelled.
- .5 Defective work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the work of this Section.

3.2 **SUBFLOOR TREATMENT**

- .1 Flooring shall be installed over subfloors conforming to ASTM F710 for concrete.
- .2 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- .3 Apply sub-floor filler to low spots and cracks to achieve floor level to a tolerance of 1:1000, allow to cure.
- .4 Meet ASTM F710 Standard for Concrete or other monolithic floors.
- .5 Clean and remove all deleterious materials from surfaces to receive this work in accordance with the adhesive manufacturer's recommendations.
- .6 Prime concrete to flooring manufacturer's printed instructions.

3.3 **RESILIENT SHEET FLOORING APPLICATION**

- .1 Install resilient sheet flooring in accordance with manufacturer's written instructions.
- .2 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturers instructions. Do not spread more adhesive that can be covered by flooring before initial set takes place.
- .3 Run sheets in direction of traffic. Double cut sheet joints and continuously seal according to manufacturer's printed instructions. Remove adhesive seepage of seams or surface while adhesive is still wet.
- .4 Heat weld seams in accordance with ASTM F1516 and manufacturer's printed instructions.
- .5 As installation progresses and after installation, roll flooring with minimum 45 kg roller to ensure full adhesion.
- .6 Cut flooring neatly around fixed objects.
- .7 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.
- .8 Install reducing edge strips at unprotected or exposed edges where flooring terminates or where there are two finishes of different thicknesses.

3.4 **RESILIENT BASE APPLICATION**

- .1 Resilient base: In accordance with Section 09 65 19. Coordinate with noted Section as required for installation of resilient base with resilient sheet flooring.

3.5 **CLEANING AND SEALING**

- .1 Forty-eight hours after installation, clean sheet flooring surfaces with a mild soap solution approved by finish manufacturer. Rinse clean and allow to dry.

3.6 **PROTECTION OF FINISHED WORK**

- .1 Protect floors and bases from time of final set of adhesive until accepted by Consultant.
- .2 Prohibit traffic on floor for 48 hours after installation.
- .3 Cover cleaned surfaces with fibre reinforced, clean, non-staining clean, kraft paper. Secure in position with gummed tape to prevent drifting. Remove covering when directed by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for concrete floor sealer work in accordance with the Contract Drawings.
- .2 Concrete floor sealer to be applied on back house flooring areas in locations indicated on Drawings.

1.2 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Two copies of manufacturer's Product data on characteristics, performance criteria, and limitations.
 - .2 Preparation, installation requirements and techniques, Product storage, and handling criteria.
- .2 Samples: Submit samples in accordance with Section 01 33 00 indicating coating and final concrete finish.
- .3 Reports: Submit manufacturer's acceptance of substrate prior to installation in writing. Submit verification of moisture content of floor prior to installation.
- .4 Close-out submittals: Submit maintenance data for incorporation into Operations and Maintenance manuals in accordance with Section 01 78 00.

1.3 **QUALITY ASSURANCE**

- .1 Perform work of this Section by a company that has a minimum of five years proven experience in installations of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Mock-up:
 - .1 Construct one 2 m² mock-up of floor sealer in location acceptable to Consultant.
 - .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with Work.
 - .3 Mock-up may remain as part of Work if accepted by Consultant. If sealer application is unacceptable to Consultant, rework sealer in accordance with manufacturer's recommendations to provide a sealed concrete surface acceptable to Consultant.
 - .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.
- .3 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review mock-up and installation procedures 48 hours in advance of installation.

1.4 **SITE CONDITIONS**

- .1 Do not install the work of this Section outside of environmental ranges as recommended by the manufacturer without Product manufacturer's written acceptance and as follows:
 - .1 Relative Humidity: In accordance with manufacturers' requirements.
 - .2 When no dust is being raised.
 - .3 In well-ventilated and broom clean areas.
- .2 Install temporary protection and facilities to maintain the Product manufacturer's, and the above specification, environmental requirements for 24 hours before, during, and 24 h after installation.
- .3 Post do not enter and appropriate warning signs at conspicuous locations.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- .1 Store materials at site in an area specifically set aside for purpose that is locked, ventilated, and maintained at a minimum temperature of 16°C.
- .2 Ensure that health and fire regulations are complied with in storage area, and during handling and application.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, sealers and coatings are to have low VOC content limits.
- .2 Each material used in the application of each flooring system shall be as recommended or manufactured by the supplier of the flooring system.
- .3 Concrete floor sealer (SCONC.1): Alkali-silicate, water-soluble, inorganic concrete hardener and dustproofers; 'MasterKure HD 200WB' by Master Builders Solutions or 'Sikafloor 3S' by Sika Canada Inc.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Test surfaces for moisture content to ensure that they are suitable for application.

3.2 PREPARATION

- .1 Prepare substrate in accordance with manufacturer's written instructions. Diamond grind and vacuum substrate free of debris and dust.
- .2 Protect adjacent surfaces from damage resulting from work of this Section. Mask and/or cover adjacent surfaces, fixtures, and equipment as necessary.
- .3 Clean surfaces to be sealed as recommended by sealer manufacturer.

3.3 APPLICATION

- .1 Apply concrete floor sealer in accordance with manufacturer's written instructions. Sealer manufacturer shall supervise application.
- .2 Spray apply concrete sealer to entire surface and keep from drying for 30 minutes as recommended by manufacturer.
- .3 Sprinkle surface with water as sealer begins to penetrate (after 30 minutes).
- .4 Flush surface with water and drying begins to remove excess material. Allow to harden for 24 hours.
- .5 Lightly buff floor with a commercial floor buffer and non-aggressive pad to bring up required sheen.
- .6 Apply second coat of concrete sealer following same procedures as first layer.

3.4 CLEANING

- .1 Remove promptly as work progresses spilled or spattered materials from surfaces of work performed under other Sections. Clean floors on completion of work. Do not mar surfaces while removing.

3.5 PROTECTION

- .1 Erect barriers to prevent the entry and presence of personnel not performing work of this Section during application of floor sealer, and for 48 hours following completion of application.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

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

1.2 **REFERENCES**

- .1 The Carpet and Rug Institute (CRI), Carpet Installation Standards, No. 104.
- .2 CAN/CGSB 4.155-M, Flammability of Soft Floor Covering.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit two copies of manufacturer's Product data for each product specified in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 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 33 00.
 - .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 78 00.

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.

2 **Products**

2.1 **MATERIALS**

- .1 General: All materials under work of this Section, including but not limited to, adhesives are to have low VOC content limits.
- .2 Carpet tile (CPT.1, CPT.2): Carpet type and size to be selected by Consultant.
- .3 Seaming tape: Types recommended by carpet manufacturer for purpose intended.
- .4 Adhesive connectors (carpet tile): Pressure sensitive adhesive squares/circles for glue-free installation. 'Tac-Tile' by interface, 'Lok Dots' by Shaw Contract Group or approved alternative.
- .5 Reducing edge strips, thresholds: Nitrile rubber plasticized vinyl, 80-95 Shore A Durometer, adhesive as recommended by manufacturer.
 - .1 'Finishing Accessories' by Tarkett or approved alternative.
- .6 Thresholds, mouldings, etc.:
 - .1 Provide carpet moulding 'Johnsonite T-Mouldings, CD-XX' by Tarkett or approved alternative where carpets of different colours meet.
 - .2 Provide carpet threshold 'Johnsonite Thresholds, VT-XX-M' by Tarkett or approved alternative where carpet abuts edge of ceramic/porcelain tile.
 - .3 Provide carpet transition 'Johnsonite Wheeled Traffic Transitions, CTA-XX' by Tarkett or approved alternative where carpet abuts resilient tile and sheet flooring.
 - .4 Provide carpet edge guard 'Johnsonite Edge Guards, EG-XX' by Tarkett or approved alternative at exposed carpet edges.
- .7 Carpet protection: Non-staining heavy duty kraft paper.
- .8 Resilient base: In accordance with Section 09 65 19.

- .9 Concrete skim coat compound: High-performance, rapid-setting cement based skim coating compound. 'Planiprep SC' by Mapei or approved alternative for filling minor voids and leveling existing substrate.

3 Execution

3.1 **EXAMINATION**

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

3.2 **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.
- .4 Ensure toeless type resilient base has been installed before proceeding with carpeting.

3.3 **CARPET TILE INSTALLATION**

- .1 Install floor carpet in accordance with pattern layout and reviewed shop drawings, manufacturer's printed instructions and in accordance with The Carpet and Rug Institute (CRI), Carpet Installation Standards, No. 104.
- .2 Cut and install carpet to fit tightly and neatly around perimeter of carpeted areas, around permanent fixtures and around projections through the floor.
- .3 Adhesive connector method:
 - .1 Perimeter tiles shall be cut net to wall, where perimeter tile does not extend to a surface for butting, perimeter tile shall be installed using adhesive.
 - .2 Lay anchor rows, placing adhesive connector at every joint.
 - .3 Install remaining carpet using step method and placing a adhesive connector at every corner.
- .4 Butt all carpet tiles to tight contact to make all joints as inconspicuous as possible.
- .5 Finish installation to present smooth wearing surface free from mis-alignment, lifting, burring and other faults.
- .6 Use material from same dye lot. Ensure colour, pattern and texture match within any one visual area. Maintain constant pile direction.

- .7 Continue carpeting through passageways and extend carpet into recesses, such as closets, and under movable casework, equipment and other movable items.
- .8 Terminate carpeting at centerline of door, in closed position, in openings where adjacent floor finish or colour is dissimilar.
- .9 Install base in accordance with Section 09 65 19.

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

1 General

1.1 **SECTION INCLUDES**

- .1 Design, Labour, Products, equipment and services necessary for acoustical panels work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, limitations, and trouble-shooting protocol.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop Drawings:
 - .1 Submit Shop Drawings in accordance with Section 01 33 00 indicating:
 - .1 Elevations, sections, details, materials, dimensions, and finishes.
- .3 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00.
 - .1 Two 300 x 300 mm samples of each acoustical panel unit required, showing full range of exposed texture to be expected in completed work and one 300 x 300 mm sample for each finish and/or colour.
- .4 Closeout submittals:
 - .1 Submit following for panels incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00:
 - .1 Performance criteria and maintenance data.

1.4 **QUALITY ASSURANCE**

- .1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of acoustical panel units of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Mock-up:
 - .1 Construct one 3 m² mock-up of acoustical panels in location acceptable to Consultant.
 - .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.

- .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
- .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- .1 Prevent soiling, physical damage or wetting.
- .2 Store cartons open at each end to stabilize moisture content and temperature.

1.6 **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: 13°C to 21°C.
 - .2 Precipitation: None.
 - .3 Relative Humidity: 65 to 75%
- .2 Do not install acoustical panels until building is closed in and HVAC system is operational.
- .3 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 24 hours before, during, and 24 hours after installation.

1.7 **MAINTENANCE**

- .1 Submit extra 3% of gross area covered, for each pattern and type specified. Submit Products from same production run as installed products. Store maintenance Products as directed by Consultant.

2 **Products**

2.1 **MATERIALS**

- .1 General:
 - .1 All materials under work of this Section, including but not limited to, adhesives and touch-up paints are to have low VOC content limits.
 - .2 All dimensional lumber used to be FSC certified.
- .2 Acoustical wall panel: ASTM E84, Class A.
 - .1 Core: 100% PET (Polyethylene Terephthalate); 60% recycled material.
 - .2 Finish:
 - .1 Etched #3 - STRIPE.
 - .2 Etched #9 - FULL STRIPE.
 - .3 Panel size: 12 mm thick, custom shapes as indicated on Drawings.
 - .4 NRC: 0.4-1.

- .5 Attachment method: Adhesive as recommend by manufacture.
- .6 Acceptable Manufacture: 'Etched Wall Tiles' by Hush Acoustics or approved alternative.
- .3 Moulding: Plastic, in colour to match panels.
- .4 Fasteners: Concealed, stainless steel Type 304.

2.2 **FABRICATION**

- .1 Verify dimensions of existing work before commencing fabrications and report discrepancies to Consultant.
- .2 Fabricate work in accordance with Contract Drawings and reviewed shop drawings. Fabricate, fit and assemble work in shop where possible. Where shop fabrication is not possible, make trial assembly in shop.
- .3 Fabricate work free from defects impairing function, appearance, strength and durability.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Install panels, support and adhesive, trim and related items to lines and elevations indicated and in strict accordance with reviewed shop/erection drawings and manufacturer's printed instructions. Carefully co-ordinate work with other Sections.
- .2 Install Panels to Shop Drawings and manufacturer's printed instructions. Damaged panels, waviness, warp or distortion of finished work will not be accepted.
- .3 Cover field cut edges by means of trim or other moldings.

3.3 **CLEANING**

- .1 Clean exposed surfaces of acoustical panel, trim, moldings and suspension members to comply with manufacturer's instructions for cleaning.
- .2 Touch up any minor finish damage.
- .3 Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.4 PROTECTION

- .1 Protect installed work from damage due to subsequent construction activity, including temperature and humidity limitations and dust control, so that the work will be without damage and deterioration at the time of acceptance by the Owner.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

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

1.2 **REFERENCES**

- .1 Master Painters Institute (MPI), Painting Specification Manual.
- .2 SSPC Steel Structures Painting Council, Standards.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Submit listing of manufacturer's Product types, Product codes, and Product names, number of coats, and dry film thicknesses, corresponding to each Painting Schedule code; submit listing minimum of 8 weeks before materials are required.
- .2 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00.
 - .1 Three 300 x 150 mm draw downs of each colour minimum 4 weeks before paints are required.
 - .2 Identify each sample with Contract number and title, colour reference, sheen, date, and name of applicator.
- .3 Certificates:
 - .1 Submit certification from paint manufacturer, on company letterhead, indicating each product proposed for use is Manufacturer's premium grade, first line Product.
 - .2 Submit certified documentation to confirm each airless spray painter has minimum of 5 years experience on applications of similar complexity and scope.
 - .3 Submit certified documentation to confirm each worker has Provincial Tradesman Qualification certificate of proficiency.
- .4 Reports:
 - .1 Submit written field inspection and test report results after each inspection.
 - .2 Submit Field Quality Control test result reports for alkali content, substrate moisture, and dry film thickness.
 - .3 Submit electronic moisture meter manufacturer's specifications including tolerances. Submit record of latest meter calibration to meet manufacturer's recommendations.

1.4 **QUALITY ASSURANCE**

- .1 Finishing work: Perform work to MPI requirements for premium grade.
- .2 Supervision: Have work supervised by a full-time qualified foreperson who has 10 years minimum experience on Contracts of similar complexity and scope.
- .3 Mock-up:
 - .1 Construct three 3 m² mock-ups of different Paint Schedule code systems, selected by Consultant, in locations acceptable to Consultant to demonstrate installation workmanship, colour, and hiding power of Products.
 - .2 Obtain Consultant's acceptance in writing before proceeding with the work of this Section.
 - .3 Mock-ups may remain as part of the Work if acceptable to Consultant and will serve as a standard for similar code systems.
 - .4 Repaint over mock-ups which do not form part of the Work.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- .1 Install correct, safe temporary storage for paint, thinner, solvents, and other volatile, corrosive, hazardous, and explosive materials in accordance with requirements of authorities having jurisdiction.
- .2 Post hazard warning signage in areas of storage and mixing. Install and maintain sufficient CO₂ fire extinguishers of minimum 9 kg capacity, accessible in each storage mixing and storage areas.
- .3 Maintain storage enclosures at minimum 10°C ambient temperature and to manufacturer's instructions.

1.6 **SITE CONDITIONS**

- .1 Apply coatings under the following conditions:
 - .1 Exterior coatings (except Latex): 5° C minimum.
 - .2 Exterior latex coatings: 10°C minimum.
 - .3 24 hours minimum after rain, frost, condensation, or dew.
 - .4 When no condensation is possible (unless specifically formulated against condensation).
 - .5 Interior coatings: 7°C minimum.
 - .6 Relative humidity: 85% maximum.
 - .7 Not in direct exposure to sun light.
- .2 Maintain temperature conditions indicated above for 24 hours before, during and 24 hours after painting.
- .3 Install clean plywood sheets to protect floors and walls in storage and mixing areas, from paint drips, spatters, and spills.

- .4 Apply sufficient masking, clean drop cloths, and protective coverings for full protection of work not being painted including, but not limited to, the following:
 - .1 Light fixtures, fire and smoke detectors.
 - .2 Sprinkler heads.
 - .3 Prepainted diffusers and registers.
 - .4 Prepainted equipment.
 - .5 Fire rating labels and equipment specification plates.
 - .6 Finished surfaces.

1.7 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

- 1. Provide paint products meeting MPI "Green Performance Standard GPS-1-12".

1.8 MAINTENANCE

- 1. Deliver to Owner's place of storage on completion of work, sealed containers of each finish painting material applied, and in each colour. Label each container as for original, including mixing formula. Provide the following:
 - .1 1 L of extra materials when less than 50 L are used for Project;
 - .2 3.78 L of extra stock when 50 to 200 L are used;
 - .3 7.57 L of extra stock when over 200 L are used.

2 Products

2.1 MATERIALS

- .1 Paint:
 - .1 All materials under work of this Section, including but not limited to, primers, stains, and paints are to have low VOC content limits.
 - .2 Products in accordance with the MPI Painting Specification Manual, Exterior and Interior Systems;
 - .1 For each MPI paint code, manufacture's premium grade, first line Products is to be use.
 - .2 Uniform dispersion of pigment in a homogeneous mixture.
 - .3 Ready-mixed and tinted whenever possible.
 - .3 Products within each MPI paint system code: From single manufacturer.
 - .4 Acceptable manufacturers:
 - .1 AkzoNobel.
 - .2 Benjamin Moore.
 - .3 PPG Industries Inc.
 - .4 Sherwin Williams.

2.2 COLOUR SCHEDULE

- .1 Consultant will select choice of colours and gloss when compiling a Colour Schedule after award of Contract; allow for colour selection beyond paint manufacturer's standard colour range.
- .2 Refer to Colour Schedule for selected colour references.

- .3 Conform to gloss reflectance definitions listed in MPI Specification Manual.

2.3 PAINTING AND FINISHING SCHEDULE

- .1 Refer to Table 1, MPI Painting and Finishing Schedule coded systems, comply with MPI Painting Specification Manual.

Table 1: Painting and Finishing Schedule				
EXTERIOR SUBSTRATES	Typical substrates (Including but not limited to)	MPI Manual Ref.	MPI Finish System Code	Topcoat
Galvanized steel	HM doors & frames, handrails, bollards, pipes	EXT 5.3	EXT 5.3K	WB light industrial coating
INTERIOR SUBSTRATES	Typical substrates (Including but not limited to)	MPI Manual Ref.	MPI Finish System Code	Topcoat
Concrete walls and ceilings		INT 3.1	INT 3.1A	Latex
Concrete floors		INT 3.2	INT 3.2A	Latex enamel
Concrete floors		INT 3.2	INT 3.1A	Latex
Concrete floors		INT 3.2	INT 3.2	Epoxy
Concrete block masonry		INT 4.2	INT 4.2A	Latex
Structural steel (Factory primed)	Columns, beams, joists	INT 5.1	INT 5.1R	High performance latex
Metal Fabrications (Factory primed)	Ladders, fabrications	INT 5.1	INT 5.1R	High performance latex
Steel (High heat)	Boilers, pipes, flues, heat exchangers	INT 5.2	INT 5.2A	Heat resistant enamel
Galvanized steel	Ducts, pipes, metal deck	INT 5.3	INT 5.3A	Latex

Table 1: Painting and Finishing Schedule				
Galvanized metal	HM doors & door frames, handrails	INT 5.3	INT 5.3K	WB light industrial coating
Dressed lumber	Doors and frames requiring paint finish	INT 6.3	INT 6.3A	High performance latex
Dressed lumber	Doors and frames requiring stain finish	INT 6.3	INT 6.3E	Polyurethane varnish
Wood paneling & casework	Partitions, panels, millwork	INT 6.4	INT 6.4C	Semi-transparent stain
Gypsum board,	Drywall, walls, ceilings	INT 9.2	INT 9.2A	Latex
Gypsum board,	Wet areas	INT 9.2	INT 9.2F	Epoxy-modified latex

3 Execution

3.1 EXAMINATION

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

3.2 PREPARATION

- .1 General:
 - .1 Clean substrate surfaces free from, dust, grease, soiling, or extraneous matter, which are detrimental to finish.
 - .2 Patch, repair, and smoothen minor substrate defects and deficiencies e.g. machine, tool and sand paper marks, shallow gouges, marks, and nibs.
 - .3 Clean, sweep, and vacuum floors and surfaces to be painted, debris and dust-free prior to painting.
 - .4 Refer to MPI Painting Specification Manual for surface preparation requirements of substrates not listed here.
- .2 Where finish hardware has been installed remove, store, re-install finish hardware, to accommodate painting. Do not clean hardware with solvent that will remove permanent lacquer finishes.

- .3 Alkali Content tests and neutralization:
 - .1 Test for ph level using litmus paper on dampened substrate.
 - .2 Neutralize surfaces over 8.5 ph with 4% solution of Zinc Sulphate for solvent based systems and tetrapotassium pyrophosphate for latex based systems, to below 8.0 ph, and allow to dry.
 - .3 Brush-off any residual Zinc Sulphate crystals.
 - .4 Coordinate paint system primer / sealer to be alkali-resistant.
- .4 Substrate moisture tests:
 - .1 Test for moisture content over entire surface to be painted, minimum one test/ 2 m² in field areas and one test/600 mm along inside corners including at ceiling to wall juncture.
 - .2 If any test registers above 10% allow entire substrate surfaces, within the plane, to dry further before paint system application. Install temporary drying fans if necessary.
 - .3 Re-test employing same criteria.
- .5 Cementitious and masonry (Concrete, block, brick, stucco, cement rendering):
 - .1 Allow 28 days cure before painting.
 - .2 Coordinate repair of protrusion-chipping and grinding, and honeycomb filling with responsible trades.
 - .3 Remove dirt, loose mortar, scale, powder, efflorescence, and other foreign matter.
 - .4 Remove form oil and grease with trisodium phosphate, rinse, and allow to dry thoroughly.
 - .5 Remove rust stains with solution of sodium metasilicate after thorough wetting; allow to dry thoroughly.
- .6 Galvanized steel sheet:
 - .1 Z275 (Satin & Spangled Sheet): SSPC SP7 brush blast.
 - .2 ZF075 (Wiped Coat): Remove contamination, wash with Xylene solvent.
 - .3 Touch-up damaged galvanized areas with organic zinc rich primer.
- .7 Galvanized iron and steel: Prepare galvanized and ungalvanized metal surfaces as follows:
 - .1 Unpassivated, unweathered and weathered: Remove contamination, wash with Xylene or Toluol solvent, allow to dry thoroughly. Make paint system primer/sealer an etching type primer.
 - .2 Manufacturer pre-treated (including passivated): SSPC SP7.
 - .3 Touch-up damaged galvanized areas with organic zinc rich primer.
- .8 Structural steel and miscellaneous metal fabrications:
 - .1 Coordinate the following with the responsible trades:
 - .1 Rust, mars, mill scale, and weld-burn touch-ups.
 - .2 Oil, grease, weld flux and other residue removal.
 - .2 Prime paint items, not otherwise indicated to be primed as part of another Section.
 - .3 Touch-up damaged galvanized areas with organic zinc rich primer.

- .9 Wood and Millwork:
 - .1 Wood surfaces to be clean and dry with a moisture content of less than 15%.
 - .2 Remove foreign matter prior to prime coat; spot coat knots, pitch streaks and sappy sections with sealer.
 - .3 Fill nail holes and fine cracks after primer has dried.
 - .4 Backprime interior and exterior woodwork.
- .10 Factory primed surfaces:
 - .1 Touch up damaged areas.
 - .2 Clean as required for top coat.
- .11 Gypsum board:
 - .1 Apply primer/sealer paint to reveal defects and deficiencies and to equalize absorption areas.
 - .2 Coordinate repairs and touch-ups with the responsible trade.
 - .3 Re-prime repairs.
- .12 Coordinate with other trades to prevent:
 - .1 Damage, and inadvertent activation of fire and smoke detectors.
 - .2 Odour and dust distribution by permanent HVAC systems including fouling of ducts and filters.
- .13 Field-mix Products in accordance with manufacturer's written instructions.

3.3 **APPLICATION**

- .1 Apply painting systems in accordance with the MPI Painting Specification Manual. Apply each Product to manufacturer's recommended dry film thickness.
- .2 Painting systems listed are required minima, apply additional coats if necessary to obtain substrate hiding acceptable to the Consultant.
- .3 Tint intermediate coats lighter than final top coats for identification of each succeeding coat and to facilitate inspections. Include only manufacturer's recommended reducing and tinting accessories. Do not add adulterants.
- .4 Primer to be specialized primer coating system as required by manufacturer for selected colour. Standard primer being tinted shall be tinted to a maximum of 1.5% by volume.
- .5 Sand lightly between coats to achieve a tooth or anchor for subsequent coats.
- .6 Apply paint uniformly in thickness, colour, texture, and gloss, as determined by the Consultant under adequate illumination and viewed at a distance of 1500 mm. Apply finishes free of defects in materials and application which, in the opinion of the Consultant, affect appearance and performance. Defects include, but are not limited to:
 - .1 Improper cleaning and preparation of surfaces.
 - .2 Entrapped dust, dirt, rust.
 - .3 Alligatoring, blisters, peeling.
 - .4 Scratches, blemishes.
 - .5 Uneven coverage, misses, drips, runs, and poor cutting in.

- .7 Do not apply coatings on substrates which are not sufficiently dry. Unless indicated otherwise, allow each painting system coat to cure dry and hard before following coats are applied.
- .8 Repaint entire areas of damaged or incompletely covered surfaces, to the nearest inside or outside corner; patching will not be permitted.
- .9 Miscellaneous painting requirements:
 - .1 Paint projecting ledges, and tops, bottoms and sides of doors both above and below sight lines to match adjacent surfaces.
 - .2 Paint door frames, access doors and frames, door grilles, prime coated butts, and prime coated door closers to match surface in which they occur.
 - .3 Finish closets and alcoves as specified for adjoining rooms.
 - .4 Paint light coves white whether a light lense is installed or not, unless otherwise indicated.
 - .5 Paint interior columns to match walls of room.
 - .6 Allow for:
 - .1 2 wall colours per room, one ceiling colour per room.
 - .2 Different door colours in each functionally different area.
 - .3 Different colours on both sides of same door.
- .10 Mechanical, electrical and other painting coordination:
 - .1 Paint mechanical services in accordance with Mechanical Identification Division 21, 22 and 23.
 - .2 Coordinate painting of pipes, ducts, and coverings with the work of Division 21, 22 and 23 to precede pipe colour banding, flow arrows, and other pipe identification labeling installation.
 - .3 Paint exposed conduit, pipes, hangers, ductwork, grilles, gratings, louvres, access panels, fire hose cabinets, registers, convactor and radiator covers, enclosures, and other mechanical and electrical equipment including services concealed inside cupboard and cabinet work; apply colour and sheen to match adjacent surfaces, except as noted otherwise.
 - .4 Paint portions of surfaces such as duct interiors, piping, ductwork, hangers, insulation, walls, and similar items, visible through grilles, louvres, convactor covers etc., matte black in colour.
 - .5 Remove the following to accommodate painting, carefully store, clean, then re-install on completion of each area and when dry:
 - .1 Switch and receptacle plates, fittings and fastenings, grilles, gratings, louvres, access panels, convactor covers, and enclosures .

3.4 FIELD QUALITY CONTROL

- .1 Dry film thickness tests:
 - .1 Test for film thickness over entire surface to be painted, minimum one test/2 m² in field areas and one test/600 mm along inside corners including at ceiling to wall juncture.
 - .2 If any test registers below specified thickness, re-apply paint to entire surface to nearest inside and outside corners.
 - .3 If test registers more than 50% above specified thickness, consult with paint manufacturer, determine if problem exists, offer solutions to Consultant, and repair as directed.

- .4 Re-test employing same criteria after repair.

3.5 **CLEANING**

- .1 Remove spilled, splashed, and spattered paint promptly as work proceeds and on completion of work. Clean surfaces soiled by paint spillage and paint spatters. Repair or replace damaged work, as directed by Consultant.

3.6 **PROTECTION**

- .1 Post Wet Paint signs during drying and restrict or prevent traffic where necessary.
- .2 Post sign, after Consultant's inspection and acceptance of each room, reading:
PAINTING COMPLETE - NO ADMITTANCE WITHOUT CONTRACTOR'S PERMISSION.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for epoxy wall and ceiling coating work in accordance with the Contract Drawings.

1.2 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Two copies of manufacturer's Product data on characteristics, performance criteria, and limitations.
 - .2 Preparation, installation requirements and techniques, Product storage, and handling criteria.
- .2 Samples: Submit duplicate samples of each type and colour of epoxy wall and ceiling coatings mounted on 250 x 200 mm hardboard in accordance with Section 01 33 00
- .3 Reports: Submit manufacturer's acceptance of substrate prior to installation in writing. Submit verification of moisture content of substrate prior to installation.
- .4 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.
- .5 Close-out submittals: Submit maintenance data for incorporation into Operation and Maintenance manuals in accordance with Section 01 78 00 .

1.3 **QUALITY ASSURANCE**

- .1 Perform work of this Section by a company that has a minimum of five years proven experience in installations of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Mock-up:
 - .1 Construct one 2 m² mock-up of each type and colour of epoxy wall and ceiling coating in location acceptable to Consultant.
 - .2 Mock-up to demonstrate workmanship at seamless transition between epoxy wall and ceiling coating systems.
 - .3 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
 - .4 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.
 - .5 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.
- .3 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.4 SITE CONDITIONS

- .1 Do not install the work of this Section outside of the following environmental ranges without Product manufacturer's written acceptance:
 - .1 Ambient air and surface temperature: 15°C to 30°C.
 - .2 Relative Humidity: In accordance with manufacturers' requirements.
 - .3 When no dust is being raised.
 - .4 In well-ventilated and broom clean areas.
- .2 Do not apply epoxy coatings over materials that contain over 4% moisture.
- .3 Install temporary protection and facilities to maintain the Product manufacturer's, and the above specification, environmental requirements for 24 hours before, during, and 24 h after installation.
- .4 Post do not enter and appropriate warning signs at conspicuous locations.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Package, seal and label each epoxy coating materials to show manufacturer's and product name, and colour.
- .2 Store materials at site in an area specifically set aside for purpose that is locked, ventilated, and maintained at a minimum temperature of 16°C.
- .3 Ensure that health and fire regulations are complied with in storage area, and during handling and application.

2 Products

2.1 MATERIALS

- .1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits and emissions requirements.
2. Each material used in the application of each coating system shall be as recommended or manufactured by the supplier of the coating system.
3. Alternatives will be considered provided their equivalent system is approved prior to purchase.
- .4 Epoxy wall coating (EPC):
 - .1 Primer (gypsum and cement board): Water based epoxy primer, 'Sikagard Duroplast EE' by Sika Canada Inc.
 - .2 Primer (concrete, and concrete block): Water based epoxy primer, 'Sikagard Duroplast EE' by Sika Canada Inc.
 - .3 Coating: Two-component, water based, antimicrobial coating hardening to a ceramic-like appearance. 'Sikagard Duroplast 150' by Sika Canada Inc.
 - .4 Finish: Refer to Interior Finishes Materials Schedule.

- .5 Epoxy ceiling coating (ECC):
 - .1 Primer (gypsum and cement board): Water based epoxy primer, 'Sikagard Duroplast EE' by Sika Canada Inc.
 - .2 Coating: Two-component, water based, antimicrobial coating hardening to a ceramic-like appearance. 'Sikagard Duroplast 150' by Sika Canada Inc.
 - .3 Colours to later selection by Consultant from manufacturer's full range.
 - .4 Finish: Finish as selected by the Consultant satin finish.
 - .5 Finish: Refer to Interior Finishes Materials Schedule.

3 Execution

3.1 EXAMINATION

- .1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Test surfaces for moisture content to ensure that they are suitable for application.

3.2 PREPARATION

- .1 Prepare substrate using steel aggregate blast method and vacuum substrate free of debris and dust.
- .2 Fill minor cracks and voids and prime surfaces in accordance with manufacturer's recommendations.
- .3 Protect adjacent surfaces from damage resulting from this work. Mask and/or cover adjacent surfaces, fixtures, and equipment as necessary.
- .4 Fill open control joints, and other cracks and voids with material compatible with epoxy materials.
- .5 Clean prime and seal surfaces as recommended by epoxy manufacturer.

3.3 EPOXY COATING APPLICATION

- .1 Apply epoxy coatings in accordance with manufacturer's written instructions.
- .2 Apply two coats of block filler to concrete and concrete block walls to provide a pinhole free surface in accordance with manufacturer's written instructions.
- .3 After preparation of wall substrate with block filler is completed, apply epoxy coating with manufacturer recommended roller with in two coats of 4 to 6 mils (wft) thickness, unless otherwise directed.
- .4 Roll epoxy coating over tapered epoxy flooring base to provide seamless overlap.
- .5 Seamless transition between epoxy flooring, wall and ceiling coatings to meet Consultant's approval.

3.4 **REPAIR**

- .1 Touch-up and refinish minor defective work. Refinish entire coated surface areas where finish is damaged or otherwise unacceptable.

3.5 **CLEANING**

- .1 Remove promptly as work progresses spilled or spattered materials from surfaces of work performed under other Sections. Clean floors on completion of work. Do not mar surfaces while removing.
- .2 Leave storage and mixing areas in same condition as equivalent spaces in project.

3.6 **PROTECTION**

- .1 Erect barriers to prevent the entry and presence of personnel not performing work of this Section during application of epoxy coating, and for 48 hours following completion of application.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, products, equipment and services necessary for signage work in accordance with the Contract Documents.

1.2 **SUBMITTALS**

- .1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Product transportation, storage, handling and installation requirements.
 - .2 Samples: Submit two 300 x 300 mm samples of each finish specified in accordance with Section 01 33 00.
 - .3 Submit templates to Contractor for use by installers and fabricators as required for proper location and installation of hardware.

1.3 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver products to location at building site designated by Contractor.

2 Products

2.1 **GENERAL**

- .1 Incorporate fastenings and anchorage required for building in of products.

2.2 **MISCELLANEOUS PARKING LOT SIGNS**

- .1 Provide mounted prefinished metal 'No Parking', 'Fire Route', 'Accessible Parking', Electric Vehicle, and other signage as needed to City of Toronto By-laws for Parking Standards and as per WSP Signage Plans.

2.3 **STAIR SIGNAGE**

- .1 Indicate assigned floor numbers with Arabic numerals mounted permanently on the stair side of the wall at the latch side of doors to exit stair shafts.
- .2 Indicate designation assigned to each exit stair shaft with Upper case letters mounted permanently on each side of doors to the exit stair shafts.
- .3 Number dimensions: 60 mm high and raised 0.7 mm above wall surface.
- .4 Locate 1500 mm above finished floor and 300 mm maximum from the door.
- .5 Colour: to contrast with wall surface, as selected from standard range by Consultant.

2.4 **BARRIER FREE WASHROOM SIGNS**

- .1 Supply and install one (1) interior wall mounted sign adjacent to each washroom entrance door in accordance with OBC 3.8.3.1.
- .2 Colour: to contrast with wall surface, as selected from standard range by Consultant.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Provide manufacturer's information and templates required for installation of work of this Section.

3.3 **ADJUSTMENTS AND CLEANING**

- .1 Refinish damaged or defective work so that no variation in surface appearance is discernible. Refinish work at site only if acceptable.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for operable glass partition work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A36/A38M, Specification for Carbon Structural Steel.
- .2 ASTM A666, Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- .3 ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .4 ASTM B221, Specification for Aluminum-Alloy Extruded Bars, Rods, Wires, Profiles and Tubes.
- .5 ASTM B455, Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes.
- .6 ASTM C920, Specification for Elastomeric Joint Sealants.
- .7 ASTM E557, Standard Practice for Architectural Application and Installation of Operable Partitions.

1.3 **DESIGN REQUIREMENTS**

- .1 Weight of panels not to exceed 785 lbs.

1.4 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Elevations, sections, details of partitions and operating components, hardware, track support and arrangement layout, stacking details, seals, gaskets, guides, materials, lining materials, table indicating dimensions and location of each partition, dimensions, gauges, and finishes.
- .3 Certificates: Submit certification from an independent inspection company that operable glass panels meet specified design requirements.

- .4 Closeout submittals: Submit cleaning and maintenance instructions for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

2 Products

2.1 **ACCEPTABLE PRODUCT AND MANUFACTURER**

- .1 Glazed operable system:
 - .1 Folding panel aluminum and glass window system, including aluminum frame, tracks, threshold, sliding/swinging and locking hardware, and glass and glazing materials.
 - .2 System to be complete with all components and accessories as required for complete and secure installation.
 - .3 Acceptable manufacturers: 'NW Acoustical 645' by NanaWall Systems Inc.
 - .4 Refer to Section 08 70 00 for additional door hardware at swing doors.

2.2 **MATERIALS**

- .1 Aluminum components:
 - .1 Extruded Aluminum Components: ASTM B221, Alloy 6063, Temper T6.
 - .2 Aluminum sheet: ASTM B209, 5052-H32.
 - .3 Aluminum bars, and plate: ASTM B221, Alloy 6061, Temper T6.
- .2 Stainless Steel Components: ASTM A666, Type 304 or Type 316 as applicable.
- .3 Glazing: The choice of glazing for this project shall conform to specified Design Requirements, reviewed shop drawings, and Authorities having jurisdiction: Refer to Section 08 80 00 for glazing types.
- .4 Sealant: ASTM C920 Type S, Grade NS; One-part silicone sealant, as recommended by manufacturer.
- .5 Steel plate: ASTM A36/A36M.
- .6 Fasteners: As recommended by manufacturer.

2.3 **MANUFACTURED UNITS**

- .1 Operation of partitions to be top supported, manually operated, individual panels.
- .2 Panel construction to be tempered glass panels, mechanically attached to anodized aluminum rails without adhesives or friction, of equal width to close opening indicated on drawings. Maximum panel width to be 1219 mm.
- .3 Frame Finish: Clear anodized.
- .4 Top and bottom brush light seals.

- .5 Track: clear anodized tempered aluminum track supported by threaded rods.

2.4 **FABRICATION**

- .1 Verify dimensions of existing work before commencing fabrications and report discrepancies to Consultant.
- .2 Fabricate work in accordance with Contract Drawings and reviewed shop drawings.
- .3 Fabricate work free from defects impairing function, appearance, strength and durability.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Install operable glass partitions straight, plumb, and level in accordance with reviewed shop drawings, manufacturer's written instructions, and ASTM E557.
- .2 Touch up damaged finishes, repair damage to partitions to match original finish.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services for washroom accessories work in accordance with the Contract Documents.
- .2 Coordinate section with Interior Designer.

1.2 **REFERENCES**

- .1 ASTM A167, Specification for Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- .2 ASTM A312, Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
- .3 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .4 ASTM F2285, Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use.
- .5 CAN/CSA B651-M, Accessible Design for the Built Environment.

1.3 **SUBMITTALS**

- .1 Product data: Submit Product data to requirements of Section 01 33 00 indicating each washroom accessory describing size, finish, details of function, attachment methods, hardware and locks, description of rough-in frame, and building-in details of anchors for grab bars.
- .2 Closeout submittals:
 - .1 Submit for each Product operation and maintenance instructions for incorporating into the Operations and Maintenance Manuals in accordance with Section 01 78 00.
 - .1 Supply 2 keys for each lockable washroom accessory to Consultant.
 - .2 Master key washroom accessories which are keyed.
 - .3 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver materials in sealed cartons and containers with manufacturer's name and product description clearly marked.

1.5 **EXTENDED WARRANTY**

- .1 Submit an extended warranty for washroom accessories work in accordance with the General Conditions, except that the warranty period is extended to 10 years.
 - .1 Against cracked or scratched mirrors, spoiling or deterioration of silvering or backing, loosening of fastenings or adhesive
 - .2 Coverage: complete replacement including effected adjacent work.

1.6 **MAINTENANCE**

- 1. Maintenance Tools: Provide special tools necessary for accessing, assembly/disassembly or removal of toilet, bath and cleaning accessories in accordance with Section 01 10 10.

2 **Products**

2.1 **MATERIALS**

- .1 Stainless steel:
 - .1 Sheet metal: ASTM A167, Type 304.
 - .2 Tubing: ASTM A312, Type 304.
- .2 Sheet steel: ASTM A653M, Z275; Cold rolled, commercial quality, surface preparation and pretreatment as required for applied finish.
- .3 Fasteners, screws and bolts: ASTM A167, Type 304 stainless steel, tamper-proof.

2.2 **ACCESSORIES**

- .1 Refer to drawings for quantity and location of washroom accessories.
- .2 Toilet tissue dispenser:
 - .1 #B-2888 by Bobrick or #0030 by ASI Group Canada; Surface mounted, multi roll dispenser, with second roll enclosed in cabinet above.
 - .2 Finish: Type 304 stainless steel with satin finish.
- .3 Sanitary napkin disposal:
 - .1 #B-254 by Bobrick or #0473-1A by ASI Group Canada; Surface mounted, top hung upper door with multi-staked piano hinge, surface mounted stainless steel wall box and waste receptacle, full length stainless steel hinge. Receptacle capacity: 5.7 L.
 - .2 Finish: All exposed edges Type 304 stainless steel with satin finish.
- .4 Soap dispenser:
 - .1 #B-2111 by Bobrick or #0347 by ASI Group Canada; Vertical surface wall mounted dispenser, 100 mm from wall to push button, 1.18 -litre capacity stainless steel container with tamper resistant sight gauge.
 - .2 Finish: Type 304 stainless steel with satin finish.

- .5 Paper towel dispenser and receptacle:
 - .1 #B-3803 by Bobrick or #9462 by ASI Group Canada; Provide universal paper towel dispenser adjustable to dispense c-fold, single and multifold paper towels, full length stainless steel multi-staked piano hinge, stainless steel waste receptacle, complete with towel dispensing slot with adjustable guide.
 - .2 Finish: Type 304 stainless steel with satin finish.
- .6 Hand Dryer:
 - .1 #B-748-Eclipse Model by Bobrick; surface mounted, automatic hand dryer by Bobrick or approved alternative, one-piece, deep-drawn, steel cover, motor shall be 1/10 hp with sealed ball bearings and automatic thermal overload, automatic sensor with shut off after 1-1/2 min if covered by inanimate object, after removed unit will automatically reset.
 - .2 Hand dryer unit to have 115V AC, 20 Amp, 2300 Watts and 50/60 Hz.
 - .3 Finish: Chrome-plated cover.
- .7 Grab bar:
 - .1 Series B-6806-99 by Bobrick or #3800-P Series by ASI Group Canada; 38 mm diameter, 1.2 mm thick, concealed mounting with snap flange, complete with escutcheons. Lengths and configurations as indicated on drawings.
 - .2 Finish: Type 304 stainless steel with a satin finish and peened grip.
- .8 Grab bar (L-shaped):
 - .1 'Series 6898-99 - L30x30' by Bobrick Washroom Equipment or approved alternative; 38 mm diameter, 1.2 mm thick, concealed mounting with snap flange, complete with escutcheons.
 - .2 Length and configuration: 762 x 762 mm, in L-shaped configuration as shown on Contract Drawings.
 - .3 Finish: Type 304 stainless steel with a satin finish and peened grip.
- .9 Mirror: 6 mm thick, mirror quality float glass
 - .1 #B-290 Series by Bobrick or #20650 series by ASI Group Canada; mitred corners welded, and polished smooth.
 - .2 Dimensions: Sizes and locations as indicated on the Contract Drawings.
 - .3 Frame finish: Type 304 stainless steel satin finish.
- .10 Mirror (Tilt): 6 mm thick, mirror quality float glass.
 - .1 #B-293 Series by Bobrick or #0535 Series by ASI Group Canada; mitred corners welded, and polished smooth.
 - .2 Dimensions: Sizes and locations as indicated on the Contract Drawings.
 - .3 Frame finish: Type 304 stainless steel satin finish.
- .11 Coat hook:
 - .1 #B-7671 by Bobrick or approved alternative by ASI Group Canada; single robe hook, hook with flange, support arm and concealed mounting bracket.
 - .2 Finish: Type 304 stainless steel, bright polished finish.

- .12 Stainless steel shelf:
 - .1 #20692-624 Series by ASI Group Canada or approved alternative; Roval surface mouthed shelf fabricated from 1.2 mm thick stainless steel with 13 mm return edge and front edge hemmed for safety.
 - .2 Shelf complete with brackets fabricated from 1.2 mm thick stainless steel.
 - .3 Size: 100 mm wide x 600 mm long.
 - .4 Finish: Type 304 stainless steel, satin finish.
- .13 Infant sized changing station:
 - .1 Horizontal station that protrudes no more than 102 mm from wall, minimum holding capacity of 90 kg and fabricated from non-porous plastic with no metal parts visible and pinch proof use, has a damped gas spring to allow opening and closing with a single hand, unit shall have a bed-liner/multi-fold towel dispenser with a view slot to show low liner/towel, provide instructions in graphic and seven languages and identifying plaque for washroom entryway, unit shall provide no level resting place for cups, cans, bottles, cigarettes when open or closed.
 - .2 Dimensions: 914 mm wide X 519 mm back base.
 - .3 Warranty: for five years against defects.
 - .4 Model: #9012 by ASI Group Canada, KB200-00 by Bobrick Washroom Accessories or approved alternative.
- .14 Adult sized change table:
 - .1 Wall-mounted folding table with water containment system to direct fluids to drain, capable of withstanding 385 lbs, complete with coated canvas mattress.
 - .2 Table shall be fabricated from powder-lacquered stainless steel frame and be electrically operated.
 - .3 Table height to be adjustable, with range from 300 mm to 1000 mm above floor finish.
 - .4 Electrical supply: 120 v wall outlet.
 - .5 Model: Pressalit Care 2000 by Max-Ability or approved alternative.

3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Verify and coordinate templates, inserts, and rough-in frames and verify exact location of washroom accessories for installation.
- .2 Verify there is adequate supports and/or blocking in gypsum wall assemblies prior to installation of washroom accessories.

- .3 Provide fastening and mounting kits for washroom accessories.
- .4 Locate washroom accessories where indicated on Drawings and where directed by Consultant.
- .5 Install washroom accessory fixtures, accessories, and items in accordance with manufacturer's instructions and CAN/CSA B651-M. Provide exposed tamper-proof screws of stainless steel to match units.
- .6 Install washroom accessories plumb, level, and securely and rigidly anchored to substrate surfaces and framing. Adjust accessories for proper operation and verify mechanisms function smoothly.
- .7 Install grab bars to withstand minimum load of 1.3 kN applied vertically or horizontally. Provide necessary reinforcements as required.
- .8 Clean and polish exposed surfaces and fill accessories with necessary supplies prior to acceptance by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

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

1.2 **REFERENCES**

- .1 ASTM A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable
- .2 CAN/CGSB-44.40, Steel Clothing Locker.

1.3 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Shop drawings: Submit shop drawings in accordance with Section 01 33 00 indicating type and class of lockers, elevations, sections, dimensions, gauges, tops, bases, hooks, shelves, trim, numbering, doors, handles, anchorage and hardware, and finishes.
- .3 Samples:
 - .1 Submit following samples in accordance with Section 01 33 00.
 - .1 Two 50 x 50 Samples of colour and finish on actual base metal.
- .4 Closeout submittals: Submit maintenance and cleaning instruction for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

2 Products

2.1 **ACCEPTABLE MANUFACTURED**

- .1 Lockers specified herein are based on 'Standard Dura 52 Series with full height handle' by Lincora Canada Inc. Provided that they meet or exceed all specified requirements, other manufacturers approved for work of this Section are:
 - .1 Hadrian Manufacturing Inc.
 - .2 Shanahan's Manufacturing Ltd.
 - .3 Or approved alternative.

2.2 MANUFACTURED UNITS

- .1 Sheet steel: Premium quality cold rolled standard steel to ASTM A1008/A1008M.
Minimum steel core thickness as follows:
 - .1 CAN/CGSB-44.40, full height, Type 1, Class 2
 - .2 Tier: Single.
 - .3 Width: 381 mm.
 - .4 Depth: 457 mm.
 - .5 Height: 1422 mm.

2.3 FABRICATION

- .1 General:
 - .1 Confirm dimensions indicated on drawings with field dimensions.
 - .2 Accurately fit and make joints and intersecting members in true planes with adequate fastenings.
 - .3 Lockers and benches are to be robust construction, consisting of high quality materials, detailing, and installation, with no exposed sharp edges.
 - .4 Make exposed welds continuous. File and grind welds smooth and flush.
- .2 Locker bodies: Minimum 0.61 mm thick steel sheet with flanged backs and rib stiffeners on sides. Provide locker body sides with stiffening ribs. Provide flanged backs and no exposed sharp edges.
- .3 Frames:
 - .1 1.52 mm sheet steel. Steel strip folded to form a 90-degree triple fold edge. For left frames to be finished with an upside-down fold and folded back on itself to provide full height support for the door.
 - .2 Construct door frames in a box channel shape, welded and smoothly finished, incorporating two rubber door silencers on lock side of frame. Weld a one piece heavy fixed hasp and plunger to frame for padlock locking system. Padlocks not in Contract.
- .4 Hasp: 3.04 mm steel, welded to frame.
- .5 Latch: When closed, door is held in place by a permanent neodymium magnet riveted to the hasp.
- .6 Doors: Perforated for ventilation.
 - .1 Outer Panel, 1.291 mm:
 - .1 Hinge Side: Ends with two 90-degree folds.
 - .2 Handle Side: Three 90-degree folds.
 - .3 One 90-degree fold terminates at top and bottom edge of door.
 - .2 Interior Panel: MIG welded to exterior panel, 1.024 mm.
 - .3 Full Height Handle: Two vertical 90-degree folds.
 - .1 Ends with a 90-degree fold on the top and bottom edge.
 - .2 A vertical fold terminates the handle on the exposed edge to ensure a secure grip without a sharp edge.

- .3 Aluminum Plate: Glued to inside of handle protects the hasp's perimeter.
- .4 Full Height Handle: Two vertical 90-degree folds, Aluminum Plate
- .4 Door Perforations: Rectangular. Top and Bottom: 21 mm x 6 mm.
- .5 Hinge: 1.16 mm, piano. Opening: 180 degrees.
- .7 Ventilation slots: Provide ventilation slots, staggered 12 mm wide by 25 mm high oval perforations.
- .8 Bases: Galvanneal sheet steel, A653 CS TY B.
 - .1 Sheet Thickness: 20 ga (0.91 mm).
 - .2 Sloped and perforated for drainage.
 - .3 Lateral and Back Flanges: Bent 90-degrees downward.
 - .4 Front Flange: Double layered. Equivalent to a 16 ga (1.52 mm) lower frame.
 - .5 Front End: Made with a sequence of 4 bends to create a full width door strike fitted with a riveted door bumper.
 - .6 The bottom is welded to the body.
- .9 Tops: Lateral and back flanges bent 90-degrees downward and welded to the body. Provide each bank of lockers with a continuous lateral and back flanges bent 90-degrees downward top (, except where bulkheads are indicated.) Fabricate lateral and back flanges bent 90-degrees downward top with same colour and finish as locker bodies. Provide all gusset supports required.
 - .1 Sheet Thickness: 0.91 mm.
 - .2 Perforated for improved ventilation
 - .3 Front Flange: Double layered, 1.52 mm upper frame. The front third flange also creates a full width door strike fitted with a riveted door bumper.
- .10 Back: 0.76 mm, metal sheet.
- .11 Sides: 0.76 mm, metal sheet.
- .12 Shelves: 0.76 mm, metal sheet.
- .13 Coat Hooks: Flat. 13 mm x 3 mm welded on plates which are spot-welded to sides and back panels. Rounded edges.
- .14 Bumpers: Polyethylene riveted to top and bottom of the inside frame.
- .15 Accessories:
 - .1 Recessed Base: 1.21 mm, galvannealed steel, ASTM A653 / A653M G30. Black or same finish as locker.
 - .2 Height: 102 mm.
 - .3 Recessed: 76 mm.
 - .4 Number Plates: Black plastic..
 - .5 Finishing box end panel.

2.4 SHOP FINISHING

- .1 Clean, degrease and neutralize steel components with phosphate or chromate treatment.

- .2 Finish lockers, panels, tops, dust trim, hat shelf and base with primer and one coat of high performance polymer powder coating or one coat of baked enamel. Provide all surfaces with one colour.

- .3 Colour: to be selected by the Consultant.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Assemble and Install lockers in accordance with reviewed shop drawings and manufacturer's written instructions.
- .2 Securely fasten lockers to bases and grounds and nailing strips and to each other when in locker banks.

3.3 **CLEANING**

- .1 Touch up scratches and abrasions to match original finish. Clean and polish lockers prior to final acceptance by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for miscellaneous specialties work in accordance with the Contract Documents.

1.2 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data for each Product specified in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Shop drawings: Submit shop drawings in accordance with Section 01 33 00 indicating elevations, sections, details, dimensions, materials, gauges, and finishes.
 - .3 Closeout submittals: Submit cleaning and maintenance instructions for miscellaneous specialties for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.3 **DELIVERY, STORAGE, AND HANDLING**

- .1 Package or crate, and brace products to prevent distortion in shipment and handling. Label packages and crates, and protect finish surfaces by sturdy wrappings.

2 Products

2.1 **MANUFACTURED UNITS**

- .1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits and emissions requirements.
- .2 Foot Grilles:
 - .1 Frame and Grid: Recessed type, extruded 6105-T5 aluminum alloy tread rails joined mechanically by extruded 6061-T6 aluminum alloy key lock bars. Tread rails to incorporate vinyl cushion. Furnish anchors for attachment to, or for casting in, concrete.
 - .2 Finish: Black anodized.
 - .3 Tread insert: Black rubber inserts.
 - .4 Acceptable Manufacturer: 'Pedigrid G1RR' by C/S Group, or approved alternative.

- .3 Janitor's shelf with mop and broom holders and hooks:
 - .1 #B-239 x 34 by Bobrick Washroom Equipment of Canada or approved alternative.
 - .2 330 mm H by 205 mm deep. Shelf constructed of minimum 1.2 mm stainless steel, mop and broom holders to have spring loaded rubber cam to grip handles up to 30 mm in diameter, and stainless steel hooks positioned below shelf.
 - .3 Finish: Type 304 stainless steel with satin finish.
- .4 Stainless steel corner guard (CG-1): 16 mm x 16 mm x 1100 mm long, 90° angle stainless steel corner guard. Surface mounted 'CO-8' by C/S Group or approved alternative by McGill Architectural Products.
- .5 Stainless steel corner guard (CG-2): 1100 mm long, 'U' Shaped stainless steel corner guard. Surface mounted, manufactured by C/S Group or approved alternative by McGill Architectural Products.
- .6 Whiteboard (WB):
 - .1 Porcelain on steel laminated to 8 mm impregnated core with zinc coated backing sheet, with flat marker rail and white aluminum perimeter trim with squared corners.
 - .2 Colour and finish: Low gloss finish in white, 'Porcelain Surface' by ASI Visual Display Products or approved alternative.
 - .3 Sizes and layout: As shown on Contract Drawings.
- .7 Tackboard (TB):
 - .1 6 mm thick , 'Forbo Bulletin Board' by Forbo Flooring Systems; Colour as per Interior Finishes Schedule.
 - .2 Trim: Clear anodized, extruded aluminum, '9300 Series' as manufactured by ASI Visual Display Products or approved alternative.
- .8 Enamelled/Whiteboard boards (dry erase board):
 - .1 Enamelled whiteboard system with tray and clear anodized aluminum perimeter trim with squared corners.
 - .2 Colour and finish: High gloss finish in white.
 - .3 Sizes and layout: As shown on Contract Drawings.
 - .4 Trim shall be clear anodized extruded aluminum "9300 Series" in single horizontal OR single vertical slider as manufactured by ASI Visual Display Products or approved alternative by Global, CPE or other manufacturer approved by Consultant.
 - .5 Acceptable Manufacturer: ASI porcelain or approved alternative by Global, CPE or other manufacturer approved by Consultant.
- .9 Classroom Control Panel: 'ClassMate' Classroom Control Panel by interspec systems Ltd or Classroom Control Panel by Wolfeworks or approved alternative.

- .10 Green Wall:
 - .1 Biofilter materials included but not limited too;
 - .1 Internal air Diffusers
 - .2 Growth Media
 - .3 Plants
 - .2 Acceptable Manufacturer: 'Living Walls System' by Nedlaw.
- 3 Execution
 - 3.1 **EXAMINATION**
 - .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
 - 3.2 **PREPARATION**
 - .1 Verify substrate surfaces are solid, free from surface water, dust, oil, grease, projections and other foreign matter detrimental to performance.
 - .2 Items to be built-in: Provide information and templates required for installation of work of this Section, and assist or supervise, or both, the setting of anchorage devices, and construction of other work incorporated with products specified in this Section in order that they function as intended.
 - .3 Verify there is adequate supports and/or blocking in gypsum wall assemblies prior to installation of miscellaneous specialty items as required.
 - 3.3 **INSTALLATION**
 - .1 Install miscellaneous specialties level and securely and rigidly anchored to substrate in accordance with authorities having jurisdiction, reviewed shop drawings, and manufacturer's written instructions.
 - .2 After installation, adjust miscellaneous specialties in accordance with manufacturer's written instructions.
 - 3.4 **CLEANING**
 - .1 Clean and polish exposed surfaces prior to acceptance by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, tool, equipment and services necessary for glazed decorative screen work for roof top in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A666, Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- .2 ASTM B221/B221M, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- .3 ASTM B248, Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar.
- .4 ASTM C595, Specification for Blended Hydraulic Cements.
- .5 ASTM C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- .6 CSA-A500, Building Guards.
- .7 CSA-S157-M, Strength Design in Aluminum.

1.3 **DESIGN REQUIREMENTS**

- .1 Design glazed wind screens to CSA-A500, and CAN/CGSB-12.20-M. Perform stress analysis. Design units to accommodate live, dead, lateral, wind, seismic, handling, transportation, and erection loads.
- .2 Design glazed wind screens to securely hold glass panels and designed to withstand 135 km/h winds.
- .3 Design glazed wind screens to the following minimum loads:
 - .1 Concentrated load: 200 lbs any direction, any location.
 - .2 Uniform load: 50 lbs/lin/ft perpendicular to glass.
 - .3 Distributed load: 25 psf on glass area.
- .4 Design wind screens and connections to substrate where the bottom of the screen extends to a point below 1070 mm above finished floor level and provides fall protection to occupants to withstand the required guard and handrail loads in accordance with OBC and applicable local regulations. When requested by Consultant, provide a letter signed and sealed by a Professional Engineer certifying that glazed wind screen work conforms to OBC requirements.

1.4 SUBMITTALS

- .1 Shop Drawings:
 - .1 Submit Shop Drawings in accordance with Section 01 33 00 indicating:
 - .1 Plans, sections, details, type of extrusions, profiles, thicknesses, finishes, closures, fillers, and sealants.
 - .2 Products and glazing types.
 - .3 Anchorage inserts, system installation tolerances.
 - .4 Detailing, locations, and allowances for movement, expansion, contraction.
- .2 Samples:
 - .1 Submit two samples of following in accordance with Section 01 33 00.
 - .1 250 mm long samples of each type of extrusion and finish.
 - .2 250 x 200 mm samples of glass.
- .3 Close-out submittals: Submit data for incorporated into the Operations and Maintenance Manual as part of Section 01 78 00.

1.5 QUALITY ASSURANCE

- .1 Retain a licensed Professional Engineer, registered in Province of Ontario, to perform following services for glazed wind screens work:
 - .1 Design of glazed wind screens.
 - .2 Review, stamp, and sign Shop Drawings.
 - .3 Conduct on-Site inspections and prepare and submit inspection reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Protect surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Do not remove before final cleaning of building.

2 Products

2.1 ACCEPTABLE MANUFACTURER(S) AND SYSTEM(S)

- .1 Glazed wind screen system (channel type):
 - .1 Steel shoe: Minimum 48 mm wide x 89 mm high complete with finish cladding. Installation to be by wet-glaze method.
 - .2 Glass: 19 mm thick tempered glazing.
 - .3 Material: Type 304 stainless steel with brushed finish.

2.2 MATERIALS

- .1 General:
 - .1 All materials under work of this Section, including but not limited to, sealants and coatings are to have low VOC content limits.
 - .2 Wherever possible, metals used in work of this Section are to contain recycled content.
- .2 Stainless steel: ASTM A666, Type 304.
- .3 Aluminum: ASTM B221/B221M, extruded aluminum alloy 6063-T52.
- .4 Brass: ASTM B248, No. 260, yellow brass.
- .5 Glazing: The choice of glazing for this project shall conform to specified Design Requirements, reviewed Shop Drawings, and Authorities having Jurisdiction:
 - .1 Tempered glass: ASTM C1048, Kind FT, Quality q3, clear, [tinted].
 - .2 Edges: Grind and polish a 1.5 mm arris to edges of exposed glazing at locations where glazing is not encapsulated in framing and where edges are exposed to occupants.
- .6 Fasteners: Stainless steel, Type 304, for assembling screen parts for attaching base shoes to substrate and for fixing brackets to wall. Coloured to match finished metal colour.
- .7 Glazing gasket: EPDM roll-in glazing gasket.
- .8 Expansion cement: ASTM C595, Hydraulic cement as approved for use.

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, fit, and secure framing joints and corners accurately, with flush surfaces, and hairline joints.
- .3 Conceal anchors, reinforcement and attachments from view. Fabricate reinforcement in accordance with design requirements.
- .4 Do not expose manufacturer's identification labels on assemblies.
- .5 Do not mar surface finishes with welds in back of exposed surfaces. Do not deform the exposed metal and finish in any way by welding.
- .6 Reinforce assemblies by concealed means. All reinforcing shall be with structural metal sections and shall be securely anchored to structure by approved positive mechanical means.
- .7 Provide devices for anchoring assemblies to the building structure with sufficient adjustment to permit correct and accurate alignment.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Install glazed wind screen work in accordance with reviewed Shop Drawings, and manufacturer's written instructions.
- .2 Install work of this Section securely, in correct location, level, square, plumb, at proper elevations, free of warp or twist.
- .3 Install closures, and trim pieces.
- .4 Refer to Contract Drawings for glazing type locations. Install glazing in accordance with Section 08 80 00.
- .5 Install glass in frames/supports properly centred with uniform bite and face and edge clearance, free from twist, warp or other distortion likely to develop stress.
- .6 Remove damaged or unacceptable Products and assemblies from Site and replace to Engineer's acceptance.

3.3 **CLEANING**

- .1 Clean surfaces of grime and dirt using acceptable and recommended means and methods.
- .2 Clean dust and drilling debris from under the framing/supports prior to their installation.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for fall protection systems work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ANSI, H35.1M Alloy and Temper Designation Systems for Aluminum (Metric).
- .2 ASTM A276, Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
- .3 ASTM B221M, Specification for Aluminum-Alloy Extruded Bars, Rods, Wires, Shapes and Tubes.
- .4 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steels.
- .5 CAN/CSA G164-M, Hot Dip Galvanizing of Irregularly Shaped Articles.
- .6 CAN/CSA S16.1-M, Limit States Design of Steel Structures.
- .7 CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.
- .8 CSA S157-M, Strength Design in Aluminum.
- .9 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
- .10 CSA W47.2-M, Certification of Companies for Fusion Welding of Aluminum.
- .11 CSA W48.1-M, Carbon Steel Covered Electrodes for Shielded Metal Arc Welding.
- .12 CSA W59-M, Welded Steel Construction (Metal Arc Welding).
- .13 CAN/CSA W117.2-M, Safety in Welding, Cutting and Allied Processes.
- .14 CAN/CSA-Z91, Health and Safety Code for Suspended Equipment Operations.
- .14 CSA Z271, Design of Suspended Access Equipment.

1.3 **DESIGN REQUIREMENTS**

- .1 Design fall protection and window cleaning systems in accordance with the Occupational Health & Safety Act and Regulations; Ont. Reg. 859/90, CAN/CSA-Z91, and CAN/CSA-Z271. Comply with the "Guidelines for Multi-Point Suspended Scaffolds (MPSS)" issued by the Ontario Ministry of Labour.

- .2 Design fall protection system in accordance with Occupational Health & Safety Act, CAN/CSA-Z91, CAN/CSA-Z271, and to withstand live, dead, seismic, imposed and other loads, and which meets proper and current window washing practices.
- .3 Design structural members with 4:1 safety factor based on ultimate strength and normal operating conditions or with limit states design as specified in referenced standards.
- .4 Design fall protection system to ensure building surfaces and finishes will not be marred or otherwise damaged during normal operation of equipment.
- .5 Design all anchor components to provide an adequate attachment means suited to current window washing practices and compatible with industry standard equipment.
- .6 As a minimum, design shall comply with CSA S16.1, CSA S136, and CAN3 S157-M.

1.4 SUBMITTALS

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations, and trouble-shooting protocol.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
 - .1 Elevations, sections, details, materials, operating components, dimensions, gauges, finishes and relationship to adjacent construction.
 - .2 Complete layout and configuration of complete fall protection system, including locations and all other components and accessories.
 - .3 Clearly indicate design and fabrication details, window drops, hardware and installation details.
 - .4 Include all necessary Restrictive and Non Restrictive Working Usage Notes and General Safety Notes.
 - .5 Complete engineering design data confirming that Products meet design criteria specified.
 - .6 Name and proof of CWB Certification or welding fabricator.
- .3 Reports/Certificates/letters:
 - .1 Provide all necessary and required test reports and certificates to comply with the relevant codes and regulations of jurisdictional authorities.
 - .2 Submit test data from an independent testing laboratory to show that all anchors which are to be used in this project meet the loading requirements of CAN/CSA-Z91-M. Anchors are to be tested after installation to loads specified in design standard in Design Requirements.

- .3 Submit inspection reports within 5 days of inspection.
- .4 Submit certified proof of product liability insurance.
- .5 Submit a letter from the Engineer certifying that fall protection system meets the performance requirements of the Ministry of Labour and standards specified in Design Requirements.
- .4 Closeout submittals:
 - .1 Provide at each roof entrance a reduced plastic laminated as-built shop drawing showing anchor locations and details, in accordance with requirements of jurisdictional authorities. Drawings shall be metal framed with clear polycarbonate scratch resistant cover and securely screwed to wall.
 - .2 Complete inspection log book, to certify fall protection system is ready for use in accordance with requirements of jurisdictional authority and for yearly inspections.
 - .3 Submit following for each Product incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00:
 - .1 Identification: Manufacturing name, type, year, serial number, number of units, capacity, and identification of related systems.
 - .2 Functional description detailing operation and control of components.
 - .3 Performance criteria and maintenance data.
 - .4 Operating instructions and precautions.
 - .5 Safety precautions.

1.5 **QUALITY ASSURANCE**

- .1 Manufacturer's qualifications:
 - .1 Execute work of this Section only by a Subcontractor specializing in the design, fabrication and installation of fall protection systems and who is also known to have been responsible for satisfactory installations similar to that specified during a period of at least the immediate past five years.
 - .2 Manufacturers shall carry specific liability insurance (products and completed operations insurance in the amount of \$ 5,000,000.00). This insurance must cover the failure of equipment and anchors.
- .2 Installers qualifications: Perform work of this Section by a company that is employed by, and under direct supervision of component manufacturer and has a minimum of five years proven experience in the installation of fall protection systems of a similar size and nature.
- .3 Retain a Professional Engineer, licensed in Province of Ontario, with experience in fall protection systems work of comparable complexity and scope, to perform following services as part of work of this Section:
 - .1 Design of fall protection system.
 - .2 Review, stamp, and sign fabrication, shop drawings, and design calculations.
 - .3 Provide letter of confirmation that structure has been designed and constructed to handle applied test loads prior to anchor testing.
 - .4 Conduct shop and on-site inspections, prepare and submit written inspection reports verifying that this part of work is in accordance with Contract Documents and reviewed shop drawings.

- .4 Execute welding by firms certified in accordance with CSA W47.1 Division 1 or 2.1 and CSA W47.2-M. Ensure welding operators are licensed per CSA W47.1 and CSA W47.2-M for types of welding required by work.

2 Products

2.1 ACCEPTABLE MANUFACTURERS

- .1 Specified manufacturer's products of Pro-Bel Enterprises Limited; Thaler Industries Ltd.; or Ankor Engineering Systems Inc. establish minimum acceptable standards for work of this Section. Equipment of other manufacturers shall meet or exceed specified manufacturer's standard. Conform to the requirements for equivalent products specified in Division 1.

2.2 MATERIALS

- .1 Structural shapes, plates, and similar items: CAN/CSA-G40.20/G40.21-M, Grade 350W.
- .2 Aluminum: ASTM B221 and ANSI H35.1 AA6063 alloy, T6 temper.
- .3 Stainless steel: ASTM A276, Type 304.
- .4 Welding materials: CSA W48.1-M and CSA W59-M.
- .5 Single stainless steel stud roof anchor: Stainless steel 'u' bar safety anchor. Mastic tape and heat shrink rubber collar for galvanized steel pier with base plate and conventional/flat flashing. Stainless steel bolted to galvanized steel back plate welded to various steel structures in accordance with Structural Drawings and Specifications.

2.3 FABRICATION

- .1 Verify dimensions of existing work before commencing fabrications and report discrepancies to Consultant.
- .2 Fabricate work in accordance with reviewed shop drawings.
- .3 Fabricate work free from defects impairing function, strength and durability.
- .4 Accurately cut, machine and fit joints, corners, copes and mitres so that junctions between components fit together tightly and in true planes. Cap open ends of sections exposed to view.

- .5 Fabricate work with materials and component sizes, metal gauges, reinforcing, anchors, and fastenings of adequate strength to ensure that it will remain free of warping, buckling, opening of joints and seams, and distortion within limits of intended and specified use and with allowable design factors imposed by jurisdictional authorities.
- .6 Weld all connections, unless otherwise indicated. Cleanly and smoothly finish exposed edges of materials including holes.
- .7 Steel pipe uprights:
 - .1 Fill steel pipe uprights with urethane foam insulation or other accepted filler.
 - .2 Size uprights for a minimum 200 mm exposure above roof membrane in accordance with good roofing practices.

2.4 **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 W48.1-M - 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 painted.
- .4 Test welds for conformance and remove work not meeting specified standards and replace to Consultant's acceptance.

2.5 **HOT DIP GALVANIZING**

- .1 After fabrication, hot dip galvanize steel items that will be exposed to the elements and as indicated. After galvanizing, plug relief vents air tight with appropriate aluminum plugs as suitable and required for intended metal fabricated item. Straighten shapes and assemblies true to line and plane after galvanizing. Repair damaged galvanized surfaces with zinc rich primer in accordance with manufacturer's printed directions.
- .2 Hot-dip galvanize members in accordance with 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.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Take site measurements of construction to which work of this Section must conform, and through which access must be made, before work is delivered to site, to ensure that adaptation is not required which would result in construction delay.

3.2 **INSTALLATION**

- .1 Install work in accordance with reviewed shop drawings and manufacturer's recommended specifications, true, tightly fitted, and level or flush to adjacent surfaces, as suitable for installation.
- .2 Provide anchorage information, roughing-in dimensions, templates, and service requirements for installation of work of this Section, and assist or supervise, or both, the setting of anchorage devices, and construction of other work incorporated with work specified in this Section in order that they function as intended.
- .3 Assemble components delivered in sections. Use only fastenings suitable for materials.
- .4 Work shall include rough hardware, fastenings, and other items necessary for secure installation.
- .5 Install work straight, plumb, level, and secured to prevent distortion or displacement, or both.
- .6 Secure components to building structure or construction as required to maintain it permanently in place, and so that it functions properly with no damaging vibration to the building or itself.
- .7 Insulate between dissimilar metals, to prevent electrolysis.

3.3 **REPAIR**

- .1 Refinish damaged or defective work so that no variation in surface appearance is discernible.

3.4 **FINAL TESTING AND INSPECTION**

- .1 Verify under work of this Section that installed products function properly, and adjust them accordingly to ensure satisfactory operation.

- .2 Fall protection roof anchors shall be inspected and tested by an independent inspection and testing body approved by jurisdictional authorities to ensure conformance to field test requirements of CSA Z271, before being used for the first time. Independent and inspection and testing body shall fill out log book in accordance with jurisdictional authority requirements.
- .3 Complete the inspection log book to certify system for use.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for supplied and installed equipment work in accordance with the Contract Documents.

1.2 **SUBMITTALS**

- .1 Product data:
 - .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations and warranties.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Samples: Submit following sample panels in accordance with Section 01 33 00. Colour and finish of each item.
 - .3 Certificates: Submit manufacturer's certificates stating that products are in accordance with this specification.
 - .4 Closeout submittals: Submit recommended maintenance instructions and listing of recommended maintenance Products for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.3 **QUALITY ASSURANCE**

- 1. Regulatory Requirements: All electrical equipment shall have attached labels attesting to CSA or Electrical Safety Authority approval, and shall have magnetic starters for motors, transformers, and overload protection.

1.4 **DELIVERY, STORAGE AND HANDLING**

- 1. Package or crate, and brace products to prevent damage or distortion of equipment in shipment and handling. Label packages and crates, and protect finish surfaces by sturdy wrappings or equivalent protection. Provide temporary skids under large or heavy units.
- 2. Do not deliver products to site until conditions are such that no damage will occur to them while in storage.
- 3. Store equipment at site in a manner to prevent damage to equipment.
- 4. Uncrate equipment only before installation.

1.5 **SCHEDULING**

1. Provide equipment or its parts ready for installation in accordance with construction schedule. Verify required delivery date sufficiently before delivery to ensure that construction is not delayed.

2 Products

2.1 **EQUIPMENT**

1. Provide reinforcing and anchorage for built-in products.
2. Insulate between dissimilar metals, and metal and masonry, to prevent electrolysis.
3. Equipment shall include all electrical components required by jurisdictional authorities, and to protect the equipment from damage during operation.
4. Equipment shall include all components, connections, devices and controls required to make it fully and safely operable.

2.2 **FABRICATION**

1. Fit joints and junctions between components tightly, in true planes, and to prevent entry of water to collect in component voids. Cap open ends of sections exposed to view.
2. Fabricate work with materials and component sizes, metal gauges, reinforcing anchors, and fastenings of adequate strength to ensure that it will remain free of warping, buckling, opening of joints and seams, and distortion within limits of intended and specified use. Conceal and weld connections wherever possible.
3. Cleanly and smoothly finish exposed edges of materials including holes and cutouts.
4. Provide reinforcing and attached anchorage for built-in products.
5. Provide holes and connections for work installed under other Sections.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
2. Before installation commences, ensure that mounting devices, members and surfaces are satisfactory for fitting, and adequate for securing of work.

3. Take site measurements of construction to which work of this Section must conform, and through which access must be made, before work is delivered to site, to ensure that adaptation is not required which would result in construction delay.

3.2 **INSTALLATION**

1. Obtain from manufacturer or supplier, anchorage information, roughing-in dimensions, templates and service requirements for installation of work of this Section. Also obtain assistance from manufacturer or supplier, for the setting of anchorage devices, and construction of other work incorporated with equipment specified in this Section in order that they function as intended.
2. Install work to meet manufacturer's recommended specifications, true, tightly fitted, and level or flush to adjacent surfaces, as suitable for installation.
3. Work shall include rough hardware, fastenings and other items necessary for secure installation.
4. Use only fastenings suitable for materials. Do not use through fastening at floors or walls.
5. Install work straight, plumb, level, and secured to prevent distortion or displacement, or both. Shim as necessary with concealed shims. Where required, use grout on which iron oxide deposits will not form.
6. Secure fixed equipment to building structure or construction as required to maintain it permanently in place, and so that it functions properly with no damaging vibration to the building or itself.
7. Install equipment with connections provided as required for plumbing and electrical services.
8. Provision of mechanical services and connection of equipment to mechanical work is specified in Division 22.
9. Provision of electrical service and connections of equipment to the services is specified in Division 26.

3.3 **REPAIR**

1. Refinish damaged or defective work so that no variation in surface appearance is discernible. Refinish work at site only if approved by Architect.

3.4 **ADJUSTING**

1. Verify under work of this Section that installed products function properly, and adjust them accordingly to ensure satisfactory operation.
2. Lubricate equipment as specified by equipment manufacturer.

3.5 **CLEANING**

1. Clean and polish all surfaces that are exposed to view from any location on completion of installation.
2. Remove packaging materials and debris from installation from the site.

3.6 **DEMONSTRATION**

1. After start-up, adjusting and cleaning, demonstrate operation of equipment to Owner and Architect, prior to Substantial Performance of the Work. Demonstrations shall be made:
 - .1 When the Work is certified complete by the Architect.
 - .2 When the Work is turned over to the Owner.
2. Knowledgeable representatives of the manufacturers and installers of the equipment being demonstrated shall be present at time of demonstrations.

3.7 **SCHEDULE OF EQUIPMENT**

1. As indicated on Selected Contractor Purchase/Contractor Install Selected Equipment.
2. As indicated on Owner Purchase/Transfer, Contractor Install Equipment.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for manually operated window covering work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 Canada Consumer Product Safety Act, Regulation SOR/2019-97.
.2 CAN/ULC-S109, Flame Tests of Flame-resistant Fabrics and Films.
.3 CWCR, Corded Window Covering Regulations.

1.3 **DESIGN REQUIREMENTS**

- .1 Design manually operated window shade system in accordance with Canada Consumer Product Safety Act, Regulation SOR/2019-97, for CWCR regulations to prevent risk of strangulation.

1.4 **SUBMITTALS**

- .1 Product data:
.1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
.1 Performance criteria, compliance with appropriate reference standard(s), characteristics, limitations, and finishes.
.2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
.1 Submit shop drawings in accordance with Section 01 33 00 indicating:
.1 Elevations, sections and details of opening size, clearances, handling of operating components, anchorage, dimensions, gauges, materials, and finishes.
- .3 Samples:
.1 Submit following samples in accordance with Section 01 33 00.
.1 Two 300 x 300 mm samples of fabric type.
- .4 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

- .5 Closeout submittals:
 - .1 Submit following for each Product for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00:
 - .1 Functional description detailing operation and control of components.
 - .2 Performance criteria and maintenance data.
 - .3 Operating instructions and precautions.
 - .4 Safety precautions.

1.5 **EXTENDED WARRANTY**

- .1 Manufacturer shall provide warranty that all components are free of manufacturing defects for two years from date of installation. This warranty is void if the product has been improperly installed or subjected to improper care.

2 Products

2.1 **ACCEPTABLE PRODUCTS AND MANUFACTURERS**

- .1 Manual roller shade: Factory assembled, manual chain operated, roller type fabric shades with "snap-in" mounting, end brackets, shade tube, aluminum fascias, soffit, hembar and fabric as indicated on drawings and as specified herein. 'Mecho SlimLine' by Mecho Shade System or approved alternative.
- .2 Manual roller shade: Factory assembled, manual chain operated, roller type fabric shades with "snap-in" mounting, end brackets, shade tube, aluminum fascias, soffit, hembar and fabric as indicated on drawings and as specified herein. 'Mecho /5 Pocket Bracket' by Mecho Shade System or approved alternative.

2.2 **SHADING FABRIC (1% OPENNESS)**

- .1 Yarn: Vinyl coated polyester, 0.46 mm thick, basket weave design.

Openness factor	1 %
Weight (g/sq.m)	23(oz./sq.yd.)
Thickness (ins.)	0.038
Breaking strength (lbs)	Warp - 340
	Fill -
Stretch %	Warp - 1.5%
	Fill - 4%
- .2 Flame retardance: Fabric shall be certified by an independent laboratory to pass CAN/ULC-S109.
- .3 Fabric colour: 'ThermoVeil 0990 Series' by Mecho Shade System, colour; 0910 Light Grey. Shade fabric on any one floor shall be from the same dye lot.
- .4 Fabric shall be sealed under heat and pressure to retain weave pattern, with additional heat seal at sides, to prevent fraying and to eliminate rough edges.

2.3 **BLACKOUT FABRIC**

- .1 Yarn: Vinyl coated polyester, 4 ply (1 ply woven fibreglass, 3 ply PVC film)
 - Weight (g/sq.m) 12 (oz./sq.yd.)
 - Tougue tear (lbs) Warp - 12
 - Fill - 8
 - Breaking Strength
 - Warp 240
 - Fill 179
 - Tear Strength
 - Warp 1,360
 - Fill 720
 - Tensile Strength
 - Warp 246
 - Fill 207
 - Flame Test
 - NFPA 701 small scale
- .2 Fabric colour: Selected by Consultant from full colour range of any of the specified manufacturers. Shade fabric on any one floor shall be from the same dye lot.

2.4 **PROJECTION SCREEN FABRIC**

- .1 3 ply (1 ply woven fibreglass, white vinyl suede embossed face/black vinyl back), weight; 12(oz/yd2).
- .2 Flame test: NFPA 701 small scale both after flame and char length)

2.5 **FABRICATION**

- .1 Extruded aluminum shade tube: 1.52 mm thick, 38 mm diameter with three internal, continuous fins 4.82 mm high for strength and drive capabilities when attached to the nylon sprocket. The fins shall be spaced 120 degrees apart.
- .2 Fascias and soffit: 1.7 mm thick, extruded aluminum cover, complete with three continuous screw flutes which accept end brackets to form unitized unit (totally assembled). To cover front and rear of shade and soffit return at underside to conceal roller and hardware[, notched for chain clearance.
- .3 Drive assemblies:
 - .1 Factory set, spring clutch type drive assembly to suit size and travel of fabric shades, complete with built-in shock absorber system to prevent chain breakage under normal conditions, and balancing spring or lift assist mechanism.
 - .2 Capable of being field adjusted from exterior of shade without having to disassemble shades.
- .4 Exterior hembar: Extruded aluminum in clear anodized finish with plastic end finials.
- .5 Drive chain:
 - .1 No. 10 "bright" finished series 300 stainless steel bead type chain forming continuous loops and capable of withstanding 400 N pull test.
 - .2 Provide drive chains with upper and lower stops to prevent overwinding or underwinding.

- .6 Tension safety/hold-down device: Provide manufacturer's standard pull chain tension/hold-down device for fastening to adjacent wall or as applicable to suit intended application, complete with fasteners and anchors as required for complete installation.
- .7 Dynamic hembar: At sill locations, in lieu of bottom channel, provide aluminum Dynamic Hembar with same finish as side channels. Upon contact with sill, it shall provide a light seal even if the sill is slightly out of level.
- .8 End bracket: Two piece moulded ABS construction with a nylon drive sprocket. Incorporate snap-in clip on each end bracket to engage snap-in mounting hardware. Bracket colour shall coordinate with the fascia colour.
- .9 Colour: Exposed surfaces (excluding fabric) shall be colour selected by Consultant, and not necessarily from manufacturer's full colour range. Metal components shall be pretreated and finished with an acceptable baked enamel finish.
- .10 Fasteners: Non-corrosive metal screws for attachment to windows or curtain wall framing, concealed in completed installation.
- .11 Mounting System: Snap-in brackets which allow the shade to be removed without disassembling the shade unit.
- .12 Shade and mounting system to be designed to allow air between shade and glass.
- .13 Fabric shall hang flat, without buckling or distortion. Trimmed edges shall hang straight without curling or raveling.
- .14 Unguided vertical shades shall not drift sideways more than 3 mm in total run.
- .15 Provide stops at highest and lowest shade positions to prevent over winding and unrolling.
- .16 Design and fabricate shades so that there is a maximum 12 mm gap both sides of fabric.
- .17 Blackout side and bottom channels: Extruded aluminum channels 38 mm x 28 mm to reduce light infiltration around sides of shade. Channels shall include 11 mm 'Fuzz' on both sides to further minimize infiltration.
- .18 Shades shall be fully factory assembled units of unitized construction consisting of end brackets, shade tube, extruded aluminum fascias, soffit return, hembar and specified fabric.

3 Execution

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

- .1 Install shades in accordance with accepted shop drawings, manufacturer's written instructions and to meet requirements of authorities having jurisdiction.
- .2 Install shades in locations shown using specified fasteners, plumb, true, square, straight, and level in proper planes, complete with all fascias/soffits, trims and accessories.

3.3 **ADJUSTMENT AND CLEANING**

- .1 The shade cloth fabric shall hang flat, without buckling or distortion. The edge, when trimmed, shall hang straight without ravelling. An unguided roller shade cloth shall roll true and straight, without shifting sideways more than 3 mm in either direction due to warp distortion, or weave design.
- .2 Adjust, correct and lubricate fabric shade as required, to provide smooth and efficient operation without binding.
- .3 Clean shade surfaces and remove all finger marks and smudges from fascias, soffits, and trim surfaces. Remove all protective films.
- .4 Leave fabric shade in raised position and in first-class condition upon completion of the work of this Section.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for miscellaneous site furnishings work in accordance with the Contract Documents.

1.2 **SUBMITTALS**

- .1 Product data:
 - .1 Submit duplicate copies of manufacturer's Product data for each Product specified in accordance with Section 01 33 00 indicating:
 - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
 - .2 Product transportation, storage, handling and installation requirements.
 - .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 indicating elevations, sections, details, dimensions, materials, gauges, and finishes.
 - .3 Closeout submittals: Submit cleaning and maintenance instructions for miscellaneous specialties for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.3 **DELIVERY, STORAGE, AND HANDLING**

- .1 Package or crate, and brace products to prevent distortion in shipment and handling. Label packages and crates, and protect finish surfaces by sturdy wrappings.

2 Products

2.1 **MANUFACTURED UNITS**

- .1 Bike Parking System:
 - .1 Four station ring rack as manufactured by Hauser Industries Inc. or approved alternative.
 - .2 Unit to be fabricated from steel pipe, and to come with exterior finish in colour to be selected by Consultant.
- .2 Bench:
 - .1 1828 mm long bench with armrests, 'Queen's Quay' as manufacturer by Hauser Industries Inc. or approve alternative.
 - .2 Seat fabricated from metal mesh. Metal finish in colours as selected by Consultant.
 - .3 Concealed bolt down glides made to fit bench.

3 Execution

3.1 **INSTALLATION**

- .1 Install miscellaneous site furnishings level and securely and rigidly anchored in accordance with reviewed shop drawings, and manufacturer's written instructions.
- .2 After installation, adjust miscellaneous site furnishings in accordance with manufacturer's written instructions.

3.2 **TOUCH UP**

- .1 Touch up material finish damaged during transit and installation, with paint to match existing.

END OF SECTION

20 00 01.00 Mechanical Supplementary Bid Form
MECHANICAL SUPPLEMENTARY BID FORM

FOR

STERLING HALL SCHOOL – PHASE 1 MASTER PLAN ADDITION
S+A PROJECT #00036.010.M.001

DATE: _____

I/we having examined the Architectural, Mechanical, Structural and Electrical Drawings, Specifications and amendments (addenda), to these documents which were issued prior to this date, along with all knowledge from site tours, site visits, and Supplemental Instructions, and I/we being aware of all conditions under which the Work/Contract will be undertaken, I/we hereby offer to furnish all materials, equipment, plant and labour necessary for the proper completion of the Mechanical Work set forth in the above mentioned Drawings, Specifications and amendments (addenda) for the stipulated sum of _____

_____ (\$ _____), in lawful money of Canada, including all prime costs, allowances and taxes.

Goods and Services Tax (GST)/Harmonized Sales Tax (HST) is not included in the above Bid price but is applicable at a value of _____

_____ (\$ _____).

This Bid price will be held open for acceptance for a period of sixty (60) days from the date of this Bid.

List of Sub-Contractors

Below are the names of the sub-contractors that will perform the respective scope of work:

Work Sublet	Name of Sub-Contractor
Plumbing and drainage	
Sheet metal	
HVAC and piping	
Fire protection	
Insulation	
Testing and balancing	
Building Automation Systems	

List of Proposed Equipment Manufacturers / Suppliers I/we herewith submit a list of manufacturers / suppliers carried in the Bid price. In the event of Contract award, I/we agree that no changes will be made to this list without prior written approval from the Consultant. (Indicate manufacturer / supplier carried for each specification section in the table below).

20 05 15.00	Variable Frequency Drives	() Danfoss () Rockwell Automation Allen-Bradley () ABB
22 11 23.29	Circulators	() Armstrong () Grundfos-Paco () Xylem Bell & Gossett () Patterson Pump Company () Taco
22 67 19.00	Domestic Water Treatment	() Culligan () BioLab
23 09 00.0X	Building Automation System (BAS)	
23 09 63.00	Laboratory Control System	() Phoenix Controls () EH Price () AirGenuity () Siemens with pressure independent venturi air valves () TSI Controls
23 21 23.00	Centrifugal Pumps	() Armstrong () Grundfos-Paco

		() Xylem Bell & Gossett, () Patterson Pump Company () Taco
23 34 73.00	Induced Flow High Plume Exhaust Fans	() Strobic () MK Plastics
23 52 16.00	Condensing Boilers	() Aerco () Viessmann () Patterson Kelley () Lochinvar () Cleaver-Brooks () Riello () Bosch () Fulton () Aerco () Cleaver-Brooks
23 52 33.14	Hot Water Dual Fired Heating Boilers (Watertube)	() Cleaver-Brooks
23 52 33.15	Steam Generators (Watertube)	() Cleaver-Brooks () Volcano () Dominion-Bridge
23 52 33.17	Hot Water Gas Fired Boilers (Flexible Tube)	() Unilux () Cleaver-Brooks () Bryan
23 52 33.20	Hot Water Gas Fired Boilers (Atmospheric)	() Laars () Raypak () Super Hot
23 52 39.19	Hot Water Gas Fired Boilers (Firetube)	() Cleaver-Brooks () Volcano () Napanee
23 52 39.20	Gas Fired Steam Boilers (Firetube)	() Volcano () Cleaver-Brooks
23 57 16.00	Heat Exchangers – Shell & Tube	() Armstrong () Taco () ITT Technologies
23 57 19.13	Heat Exchangers – Plate Type	() Xylem () Alfa-Laval () Armstrong () Tranter () APV () GEA () AIC Inc.
23 64 19.00	Reciprocating Chiller	() Daikin () Carrier () JCI York () Advance Industrial Refrigeration
23 64 29.00	Roof Mounted Air Cooled Chillers	() Daikin () JCI York () Trane () Carrier
23 64 33.00	Modular Packaged Chillers	() ModulAIR (by Advance Industrial Refrigeration) () Multistack () Daikin

		() Aermec
23 64 36.00	Chillers	() Daikin () Carrier () Trane () JCI York
23 65 43.13	Induced Draft Cooling Tower (Steel)	() Marley SPX () Baltimore Aircoil () Evapco
23 73 23.00	Custom Air Conditioning Units	() Haakon () Engineered Air () Scott Springfield () Inginia () TMI () Ventrol
23 73 23.12	Small Commercial Dedicated Outdoor Air System Packaged Units	() Oxygen8 () AuraGreen () Aldes
23 73 53.00	Compartment Units	() Haakon () Engineered Air () Racan () Ventrol
23 74 13.00	Packaged Air Conditioning Unit	() Carrier () Aaon () Daikin () JCI York
23 74 13.13	Small Packaged (Modular) Roof Mounted Air Conditioning Units	() Aaon () Daikin () Carrier () Lennox () JCI York
23 74 13.16	Roof Mounted Air Conditioning Units (High End)	() Daikin () Aaon () Engineered Air () Scott Springfield () Bousquet () Mammoth
23 74 13.19	Roof Mounted Air Conditioning Units	() JCI York () Bousquet () Daikin () Aaon
23 74 23.13	Direct Gas Fired Make-Up Air Unit	() Engineered Air () Dravo () Temprite () Reznor () Aaon () Bousquet

Cash Allowances

Include Cash Allowances in the Bid price. Include all mark ups and overhead costs in the base Bid price for these allowances. Cash Allowances are inclusive of PST where applicable, but exclude GST/HST.

Substitute Manufacturers, Material and Equipment

List any substitute equipment as a deduction from the Bid price. Acceptance of substitute equipment or material shall be at the discretion of the Owner and/or Consultant.

Item	Substitute Manufacturer	Value (Deduct)
		\$
		\$
		\$
		\$
		\$
		\$
		\$
		\$
		\$
		\$
		\$
		\$
		\$
		\$
		\$
		\$

Contractor's Suggested Deductions / Savings

We attach to this Mechanical Supplementary Bid Form a list of possible deductions from the Bid price. Describe deduction/saving in enough detail to facilitate evaluation. We fully appreciate that the acceptance of these deductions will be at the discretion of Smith + Andersen and the Owners. The Contractor is invited to study the Drawings and Specifications and submit any possible deductions to the Bid price.

Proposed Hourly Labour Cost

The hourly labour cost for providing a Journeyperson, inclusive of all charges as defined in Section 20 05 00 – General Instructions for Mechanical Sections is:

Journeyperson (Plumber)	\$	Per hour
Foreperson (Plumber)	\$	Per hour
Journeyperson (Sheet Metal Worker)	\$	Per hour
Foreperson (Sheet Metal Worker)	\$	Per hour
Journeyperson (Insulator)	\$	Per hour
Foreperson (Insulator)	\$	Per hour
Journeyperson (Sprinkler Fitter)	\$	Per hour
Foreperson (Sprinkler Fitter)	\$	Per hour
Journeyperson (Electrician)	\$	Per hour
Foreperson (Electrician)	\$	Per hour
Excavation Labour	\$	Per hour
Excavation Equipment Operator	\$	Per hour

The Owner and/or Consultant reserve the right to renegotiate the labour rate once the detailed labour rate breakdown is received.

Mechanical Bid Documents

We further confirm that we have received the following documents:

1. Mechanical Supplementary Bid Form. MECH. B.F. – 1 to MECH. B.F. – 12.
2. Mechanical Specifications – Division 20, 21, 22, and 23 consisting of the sections specified in the index at the front of the Mechanical Specification.
3. Mechanical Drawings consisting of the Drawings identified in the List of Drawings identified on the Mechanical Drawings.
4. Mechanical Amendments (addenda) listed below:

_____	Page 1 to Page _____
_____	Page 1 to Page _____
_____	Page 1 to Page _____

BID SUBMITTED BY: _____
(COMPANY)

(ADDRESS)

TELEPHONE _____

SIGNING OFFICER: _____
Print Name

SIGNING OFFICER: _____
Sign Name

Witness: _____
Print Name

Witness: _____
Sign Name

Company Seal:

END OF SECTION

20 05 00.00 General Instructions for Mechanical Sections

1. General

1.1. WORK INCLUDED

- 1.1.1. Conform to the requirements of Division 1, which applies to and forms part of all sections of the Work.
- 1.1.2. The Specification is divided into Sections which are not intended to identify contractual limits between Subcontractors nor between the Contractor and their Subcontractors. The requirements of any one Section apply to all Sections. Refer to other Divisions and Sections to ensure a complete and operational system.
- 1.1.3. Provide mechanical components and accessories which may not be specifically shown on the Drawings or stipulated in the Specifications, but are required to ensure complete and operational systems.

1.2. INTENT

- 1.2.1. Mention in the Specifications or indication on the Drawings of equipment, materials, operation and methods, requires provision of the quality noted, the quantity required, and the systems complete in every respect.
- 1.2.2. The Specifications are an integral part of the accompanying Drawings. Consider any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, as properly and sufficiently specified.
- 1.2.3. Be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment and part of equipment and repair related damages.

1.3. SECTIONS AFFECTED

- 1.3.1. These instructions apply to and form a part of all Division 20, 21, 22, and 23 Sections referred herein as Mechanical.

1.4. DEFINITIONS

- 1.4.1. Where used on the Drawings or in the Specifications, the following words are given the meanings below.
 - .1 Provide: means supply, install, connect and test.
 - .2 Demolish: detach existing items and legally dispose of them off site.
 - .3 Remove and Reinstall: Detach existing items, prepare them for reuse, and reinstall them where indicated.
 - .4 Existing to Remain: existing items that are not removed and that are not otherwise indicated as being removed, removed and salvaged (turned over to Owner), or removed and reinstalled.
 - .5 Remove and Salvage: detach existing items and turn over to Owner.

1.5. REGULATIONS

- 1.5.1. Perform Work in accordance with codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.

- 1.5.2. Comply with all guidelines and standards issued by the authorities having jurisdiction.
- 1.5.3. Where names of codes and standards are referenced on the Contract Documents, comply with the latest in force edition in the jurisdiction of the Place of the Work.
- 1.5.4. Comply with regulations respecting plumbing made under the following legislation except as modified by rules, regulations and by-laws of authorities having jurisdiction:
 - .1 Ontario Water Resources Act.
 - .2 Ontario Building Code Part 7.
- 1.5.5. For natural gas systems, follow the requirements of:
 - .1 Regulations made under the Technical Standards and Safety Act
 - .2 CAN/CSA B149.1 - Natural Gas and Propane Installation Code.
- 1.5.6. Provide materials and assemblies with flame-spread ratings and smoke developed classifications in conformance with CAN/ULC-S102 "Test for Surface Burning Characteristics of Building Materials and Assemblies." Compliance with ASTM E84 "Surface Burning Characteristics of Building Materials" in lieu of CAN/ULC-S102 is not acceptable.
- 1.5.7. These Specifications are supplementary to the requirements above.
- 1.5.8. Drawings and Specifications should not conflict with the above regulations but where there are apparent discrepancies, notify the Engineer's Representative.
- 1.5.9. Where equipment utilizing refrigerants is provided, comply with regulatory refrigerant phase out requirements and dates applicable in the jurisdiction where the Project is taking place. Where equipment not meeting refrigerant phase out requirements or dates is supplied to site, provide revised unit(s) operating on a new refrigerant at no additional cost to the Owner; cover all costs of any electrical, structural, mechanical, architectural, etc. changes required to accommodate the new refrigerant.
- 1.5.10. Where equipment described in these Specifications utilizes refrigerants, provide refrigerants that have a global warming potential (GWP) of less than 700 and that are compatible with the equipment.
- 1.6. PERMITS, FEES AND INSPECTIONS
 - 1.6.1. Obtain all permits, make submissions, pay all fees and arrange for all inspections required for the Work of this Division.
- 1.7. EXAMINATION OF SITE
 - 1.7.1. Before submitting Bids, examine the site to determine the conditions which may affect the proposed Work. No claims for extra payment will be considered because of failure to fulfil this condition.
- 1.8. DRAWINGS, CHANGES AND INSTALLATION
 - 1.8.1. The Drawings show the general character and scope of the Work and not the exact details of the installation. Install all equipment and systems complete with all accessories required for a complete and operational installation.
 - 1.8.2. The location, arrangement and connection of equipment and material as shown on the Drawings represents a close approximation to the intent and requirements of the Work. The right is reserved by the Engineer's Representative to make reasonable changes required to accommodate conditions arising during the progress of the Work, at no additional cost.

- 1.8.3. In order to show more clearly the arrangement of the Work, plans and sections do not show every valve, thermometer, pressure gauge or other system accessory. Refer to the Mechanical Standard Details and to the Specifications to determine the requirements.
- 1.8.4. Install equipment in accordance with the manufacturer's written installation requirements. In the event of conflicts between the Drawings or Specifications and the manufacturer's written installation requirements, notify the Engineer's Representative for resolution.
- 1.8.5. Certain Details indicated on the Drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details are applicable to every occurrence.
- 1.8.6. Conceal all piping and ductwork in finished areas in ceiling spaces and shafts or furred into walls. Do not install exposed piping or ductwork in such areas unless specifically reviewed and accepted by the Engineer's Representative. Do not install piping in outside walls.
- 1.8.7. Do not install vent pipes, exhaust hoods or other mechanical equipment mounted on the roof, or housing for such equipment, closer to the edge of the roof than a distance equal to the height of the pipe, hood or equipment, unless specifically reviewed and accepted by the Engineer's Representative.
- 1.8.8. The location and size of existing services shown on the Drawings are based on the best available information. Site verify the actual location of existing services before commencing Work. Pay particular attention to underground services.
- 1.8.9. Make changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other Trades, or to accommodate existing conditions, at no additional cost.
- 1.8.10. Leave areas clear of piping and ducts where space is indicated as reserved for future equipment and equipment for other Trades.
- 1.8.11. Coordinate piping low point drain locations so that they are not above or adjacent to electrical equipment, including junction boxes.
- 1.8.12. Allow adequate space and provisions for the removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.
- 1.8.13. Where equipment is shown to be 'roughed-in only,' obtain accurate information from the Engineer's Representative before proceeding with the Work.
- 1.8.14. Before fabricating ductwork or piping for installation, make certain that such items can be installed as shown on the Drawings without interfering with the structure or the Work of other Trades. Submit any problems that cannot be solved in agreement with the other Trades affected, for resolution. If ductwork or piping is prefabricated prior to the investigation and reaching of a solution to possible interference problems, make necessary changes in such prefabricated items at no additional cost.
- 1.8.15. Location of diffusers, grilles, registers, thermostats, sprinklers and all other equipment shown on plans is diagrammatic. Layout of each device in finished areas is critical in terms of symmetry and location. Refer to Architectural Drawings and to Supplemental Instructions in all regards. Revise any Work not installed in the correct location (at the sole discretion of the Engineer's Representative) at no additional cost. Mark-out fully co-ordinated Work with all other trades, in sufficient time for review by Engineer's Representative prior to rough-in. Precisely locate all mechanical and sprinkler services.
- 1.8.16. Prepare dimensioned layouts of each room prior to rough-in for review by the Architectural Consultant. Do not proceed with any Work until the Engineer's Representative has reviewed the layout.

1.9. INSTALLATION, INTERFERENCE AND SETTING DRAWINGS

- 1.9.1. Submit installation, interference and setting drawings dimensioned and to scale, for review by the Engineer's Representative, as may be required or requested by the Engineer's Representative to make clear the Work intended or to show its relation to adjacent Work or to the Work of other trades. When an alternative piece of equipment is substituted for equipment shown, prepare drawings of the area involved. Submit drawings in pdf format as well as in the format the Tender Drawings are prepared.
- 1.9.2. Prepare installation working drawings to 1:50 scale (1/4 in. equal to 1 ft.) for mechanical rooms showing plan and sections of the plant, services, bases, curbs, drains, motor terminals, etc.
- 1.9.3. Prepare interference drawings for shafts, ceiling spaces, typical floors and wherever there is possible conflict with the positioning of mechanical equipment, piping or ductwork and architectural or structural features or the Work of other trades.
- 1.9.4. The design of the structural framing of the mechanical rooms and pipe spaces and major pipe run supports has been based on assumed loadings supplied during the design phase. Well ahead of the construction of the affected areas, prepare and submit drawings for review by the Engineer's Representative showing the layout and weights of all finally selected mechanical equipment including details of concrete pads, concentrated pipe loads and point reactions of the equipment onto the structure.
- 1.9.5. Prepare sleeving drawings indicating the size and locations of openings required in concrete floor slabs, roof slabs/decks and walls for piping, ductwork and equipment. Bear the cost of all extra work necessary due to failure to provide information in time (i.e. before the concrete is poured).
- 1.9.6. Do not proceed with Work in areas involved until after final review of such drawings has been obtained.

1.10. BID FORM AND SUBMISSIONS OF BIDS

- 1.10.1. Submit with the bid, all information called for on the Bid Form. Bids not completed in full may, at the discretion of the Owner, be rejected.
- 1.10.2. Show alternative and unit prices for optional equipment or systems called for as additions to or deductions from the Bid amount.
- 1.10.3. Where only one name appears in the Specification, include the specified equipment in the Bid.
- 1.10.4. Where two or more names are shown in the Specifications as alternatives or equal to, this Division can select which manufacturer is to be carried, provided the choice is shown on the Bid Form. Where the choice is not indicated, supply the equipment described in the Specification or first named on the Bid Form.
- 1.10.5. Substitute equipment may be offered as a price deduction to the Bid price. Acceptance of substitute equipment is at the discretion of the Owner whose decision is final.
- 1.10.6. Provide materials and Products specified by the name of the manufacturer, the brand or trade name, or catalogue reference, as the basis of the Bid price. Provide these Products under the Contract unless substitutions are proposed and accepted in accordance with the following procedures:
 - .1 Substitution may be proposed only when the phrase, "or other approved manufacturer" is included in the Specification.
 - .2 List the proposed substitution under Substitute Equipment on the Bid Form.
 - .3 Indicate the Product name and provide a complete Product description.
 - .4 Clearly indicate the change in the Bid price for this substitution.

- 1.10.7. Only propose alternative and/or substitute equipment that is equal in performance and quality to that specified. Include the cost of all changes required to accommodate alternative and/or substitute equipment, in the price shown on the Bid Form, including but not limited to space, power, structural or any other requirements that are different from the equipment specified.
- 1.10.8. The Owner reserves the right to accept or reject any substitution without question.
- 1.11. MATERIALS AND EQUIPMENT
- 1.11.1. Make and quality of materials used in the construction of this Work are subject to the approval of the Engineer's Representative.
- 1.11.2. Manufacture in Canada wherever possible.
- 1.11.3. Labelled and/or Listed as required by the Authority Having Jurisdiction or Code.
- 1.11.4. Supply only new materials and equipment, free from defects of any kind and as shown or specified by the manufacturer's name and catalogue reference.
- 1.11.5. Where a manufacturer's equipment has been specified by name and/or model number, ensure that the performance and quality of equipment provided by an acceptable manufacturer, meets the specified equipment performance, is inclusive of all standard and specified optional features, and can be installed in the planned location with access and maintenance clearances in accordance with the manufacturer's written installation recommendations. Provide all required piping, duct and electrical connections at no additional cost.
- 1.11.6. Mechanical systems are designed and coordinated based on the manufacturer and model number and/or parameters indicated on the Equipment Schedules. Accept all costs for differences in physical properties or performance between scheduled equipment and acceptable alternative equipment manufacturers or models identified in these Specifications. Differences may include, but are not limited to, size, layout, arrangement of components, connection sizes, maintenance access, locations and/or quantity of service connections, and performance differences such as noise, power consumption, flow rates, etc.
- .1 Electrical coordination: accept all extra costs to revise the electrical provisions, including but not limited to feeder/wiring sizes, breaker sizes, fuse sizes, starters and equipment, to supply power to the non-basis of design piece of equipment.
- 1.11.7. Be responsible for all design costs associated with differences between scheduled equipment and alternate manufacturers or models identified in these Specifications.
- 1.12. CO-OPERATION WITH ENGINEER'S REPRESENTATIVE
- 1.12.1. To assist in the successful execution of the Project, the Contractor will receive an initial job report that summarizes the expectations of the Engineer's Representative and the Contractor. This job report covers topics such as progress billings, shop drawing requirements, Change Order pricing, the commissioning process, installation drawings, the Specifications, as-built drawings and operations and maintenance manuals, along with a number of other items. This job report is intended to reiterate key items from the Contract Documents and is not intended to impose new requirements.
- 1.12.2. At the appropriate time during construction, submit the applicable documentation listed below. The Engineer's Representative will review the information and identify when the information is complete. The Engineer's Representative's general review letter (required for building occupancy) will only be issued when the information requested below is submitted by the Contractor and deemed to be complete by the Engineer's Representative.
- 1.12.3. For mechanical systems occupancy, provide a PDF copy of the following documents to the Engineer's office for review:

- .1 CAN/ULC-S1001 "Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems" reports for mechanical systems
- .2 Fire alarm verification certificate
- .3 Sprinkler System Engineer's letters of assurance and occupancy, signed and sealed by P.Eng.
- .4 Seismic Engineer's letters of assurance signed and sealed by P.Eng.
- .5 Contractor's letter verifying that all fire fighting access routes have been provided and are accessible
- .6 Contractor's letter confirming ventilation supply air and return air available for each room
- .7 Report confirming sanitary and lab exhaust systems operational
- .8 Stair pressurization start-up report
- .9 Fuel oil system completion certificates, including authority having jurisdiction inspection certificates
- .10 Contractor's letter verifying fire stops and smoke seals installed in accordance with Mechanical Specification
- .11 Contractor's letter verifying fire damper, smoke damper, and / or combination smoke / fire damper installations are in accordance with their listings and the Mechanical Specification, and fire damper test confirmation letter
- .12 Contractor's letter verifying smoke control system is installed, operational and commissioned per Mechanical Contract Documents and Building Code requirements
- .13 Contractor's letter verifying smoke control venting to aid firefighting is installed, operational and commissioned per Mechanical Contract Documents and Building Code requirements
- .14 Contractor's letter verifying carbon monoxide detection and exhaust system is installed, operational and commissioned per Mechanical Contract Documents and Building Code requirements
- .15 Start up report(s) for heating systems, air handling unit(s), heating boiler(s), fan coil unit(s), heat pump(s), fan(s), etc.
- .16 Contractor's letter confirming that emergency power generation ventilation system is installed, operational and commissioned
- .17 Start up report(s) for ventilation systems, air handling unit(s), fan coil unit(s), heat pump(s), fan(s), exhaust fan(s), etc.
- .18 Start up report(s) for cooling systems including chillers, cooling towers, air handling unit(s), fan coil unit(s), heat pump(s), split a/c unit(s), etc.
- .19 Plumbing system pressure testing, flushing, water quality test, and chlorination report(s)
- .20 Final plumbing inspection certificate
- .21 Pressure test report on all piping systems
- .22 Contractor's letter verifying that all plumbing fixtures are installed and operational
- .23 Test reports and certificates from local building inspection authority confirming that the following items are installed, pressure tested and operational: building drains, sanitary and storm building sewers, drainage system and venting system, pipes, fittings, fixtures, etc.
- .24 Backflow preventer test reports
- .25 Contractor's letter verifying grease interceptor(s) installed and tested in accordance with Mechanical Contract Documents and Building Code

- .26 Contractor's letter verifying oil interceptor(s) installed and tested in accordance with Mechanical Contract Documents and Building Code
 - .27 Contractor's letter verifying acid neutralization system installed and commissioned in accordance with Mechanical Contract Documents and Building Code
 - .28 Contractor verification of accessibility of the fire dampers, fixtures, cleanouts, valves, plumbing appliances, devices and equipment
 - .29 Cyber Security Report Letter
 - .30 Air balancing report
 - .31 Hydronic (Piping) balancing report
 - .32 Pressure testing of refrigerant systems report
 - .33 Where the Owner has hired a third-party commissioning agent, all documentation and completion of the commissioning process submitted up to the initial BAS commissioning stage where the system is ready for season performance testing, where relevant.
 - .34 Letter from the expansion joint and anchor manufacturer: confirming that the systems have been installed in accordance with design requirements and manufacturer's installation instructions, or stating that expansion compensation is not required for the Project.
- 1.12.4. For mechanical systems financial close, provide the following additional documents to the Engineer's office for review:
- .1 Copies of as-built drawings
 - .2 Operating and maintenance manual
 - .3 Warranty letter
- 1.13. SUBSTANTIAL PERFORMANCE
- 1.13.1. The Owner will not deem the Project "ready for use" as defined in the provincial or territorial lien legislation until the following minimum items are complete:
- .1 Everything required in the clauses above for occupancy.
 - .2 All mechanical items commissioned and accepted by Engineer's Representative as noted in Specification Section 20 08 00.00 – COMMISSIONING.
 - .3 Submission of final, reviewed Operating and Maintenance Manuals including final reviewed Shop Drawings turned over to the Engineer's Representative and Owner as outlined in Section 20 08 03.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
 - .4 Submission of final, reviewed as-built documentation to the Engineer's Representative and Owner, as outlined in Specification Section 20 05 02.00 – AS-BUILT DRAWINGS. Note that this includes all final balancing reports.
- 1.14. CO-OPERATION WITH OTHER DIVISIONS
- 1.14.1. Pay particular attention to the proximity of electrical conduit and cable to mechanical piping and equipment.
- 1.14.2. Maintain at least 150 mm (6 in.) separation between pipes transporting hot fluids and pipes carrying cold fluids, unless approval from the Engineer's Representative is obtained.
- 1.14.3. Do not allow Electrical conduits to touch or be supported from piping or ductwork.

- 1.14.4. Install all materials in the spaces shown without encroaching upon space for materials installed under other Sections or Divisions. Where the space allocated to another Section or Division is encroached upon, relocate the materials to their proper space allocation in such a manner to complete the Work using space allocated to the various Sections and Divisions. Relocate materials and Work involved at no additional cost.
- 1.14.5. Supply all items to be built in ample time for rapid progress of the Work. Schedule and proceed with Work as required to satisfy the construction schedule.
- 1.14.6. Confirm the available voltage for all single phase and three phase motors or other similar electrically driven equipment with the Electrical Division prior to ordering the equipment. Report any discrepancy between the requirements identified within the Contract Documents and those of the Electrical Division to the Engineer's Representative and supply equipment to suit the appropriate power requirements. Bear all costs associated with failure to perform this coordination prior to ordering of the motors or equipment.
- 1.15. TEMPORARY USE OF EQUIPMENT
 - 1.15.1. Where systems, or a part thereof, are operated during construction, maintain the system and equipment in proper operating condition.
 - 1.15.2. Prior to application for Substantial Performance of the Work as certified by the Engineer's Representative, return the systems and/or equipment to new condition by replacing all consumables such as air or water filters, belts in belt driven equipment, etc. with new components. Clean the air side of all coils in the air handling systems, lubricate all bearings according to manufacturer's written factory standards and adjust the thermostatic control system according to Specifications. Clean all duct systems to NADCA Standards.
- 1.16. EXISTING SERVICES AND EQUIPMENT
 - 1.16.1. All changes and connections to existing services shall be made only in a manner and at a time approved by the Engineer's Representative so as to avoid any interruption of such services during normal working hours. If necessary, make changes and connections to existing services outside of normal working hours, without additional cost.
 - 1.16.2. Whenever existing services or equipment are to be removed, remove all associated piping and ducts back to the main, nearest pipe or duct and securely cap or plug open ends in an approved manner. If necessary to facilitate installation of new Work, remove existing services and equipment and then replace without additional cost.
 - 1.16.3. Whenever it becomes necessary to relocate existing piping, ducts or equipment to make possible installation of the Work under this Contract, make such relocation without additional cost.
 - 1.16.4. Where connections are made to existing services, replace and make good existing insulation.
- 1.17. INTERRUPTION OF SERVICES
 - 1.17.1. Schedule interruptions of the mechanical services to any part of the building at a time agreeable to the Owner's Representative. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.
 - 1.17.2. Obtain approval from the Engineer's Representative for testing and operation of major equipment to avoid excessive utility charges. Such testing is to be generally carried out after normal working hours or on weekends.
 - 1.17.3. Perform all such overtime Work at no additional cost.

1.18. METRIC CONVERSIONS

- 1.18.1. Take particular care with imperial versus SI metric conversions. This applies to all services including, but not limited to, equipment, pipes, ductwork and site services in both new and existing installations.
- 1.18.2. Conform to CAN/CSA-Z234.1 "Metric Practice Guide."

1.19. ALTERNATIVE AND IDENTIFIED PRICES

- 1.19.1. If alternative and unit prices have been requested, include on the Bid Form. Prices not on the Bid Form at time of submission will not be accepted. Refer to the Specifications and the Drawings for details.

1.20. PREPURCHASED EQUIPMENT

- 1.20.1. The Owner has given a letter of intent for pre-purchased equipment to the successful manufacturer.
- 1.20.2. Assume the Contract with the manufacturer. Take responsibility for this equipment under the same terms and conditions as all other equipment supplied by this Division as part of the Contract.
- 1.20.3. The following equipment has been pre-purchased:

Equipment	PURCHASE PRICE
	\$
	\$
	\$
	\$

1.21. DEMOLITION

- 1.21.1. The Drawings show the general scope of the demolition and not exact details or total extent. For exact details and total extent each service must be carefully checked on site. Before removing services, follow the service through to ensure other areas of the building are not affected. Open shafts, walls and ceilings as required to examine the services.
- 1.21.2. If there are no isolating valves readily available to isolate sections of pipe that requires removal, add valves as required. The cost of these valves will be paid for from the Cash Allowance Section. Co-ordinate with the Engineer's Representative to shut-down the system. Install caps on all services. Add caps to all valves at the termination point of existing services.
- 1.21.3. Where valves are removed, remove valve tags, revise existing charts and hand tags over to Owner.

1.22. SCHEDULE, ACCESS, PROTECTION AND CLEAN-UP

- 1.22.1. The construction schedule places restrictions on the duration of construction within areas and the duration of shut-down of equipment. Refer to the General Conditions for all requirements.
- 1.22.2. There may be access restrictions to the site (location, time of day, days of week). Refer to Front End Specifications for more information and conform to all requirements stated within.
- 1.22.3. Refer to the security and protection requirements in the General Conditions and conform to all requirements. In particular:
- .1 No open flames without prior written approval of the Owner.
 - .2 No smoking.

- .3 Keep the site clean at all times.
- 1.23. HOUSEKEEPING PADS, CURBS AND SUPPORT PIERS
 - 1.23.1. Provide dimensioned drawings for final sizes and locations for housekeeping pads, support piers, and curbs around all floor penetrations for pipes and ducts. Submit for review by Division 3 and the Engineer's Representative. Extend edge of equipment housekeeping pad 100 mm (4 in.) beyond equipment frame and hold down bolts. Refer to the Drawings and Details for additional information.
 - .1 Mechanical Division shall furnish and install curbs and housekeeping pads.
 - .2 Mechanical Division shall furnish and install equipment support piers.
 - 1.23.2. Provide housekeeping pad and curb heights as follows:
 - .1 Air handling equipment with cooling coils: 150 mm (6 in.).
 - .2 Air handling equipment with heat wheels: 200 mm (8 in.).
 - .3 Condensing boilers / condensing water heaters: 150 mm (6 in.), or as required by the manufacturer's written instructions.
 - .4 All other equipment: 100 mm (4 in.).
 - .5 Curbs around floor penetrations: 50 mm (2 in.).
- 1.24. ASHRAE 90.1
 - 1.24.1. Provide mechanical equipment that complies with the minimum efficiency standards set out in ASHRAE 90.1 "Energy Standard for Buildings Except Low-rise Residential Buildings" and the National Energy Code of Canada for Buildings. Submit all necessary information to substantiate conformance.
- 1.25. HOISTING FACILITIES
 - 1.25.1. Provide hoisting facilities for the Work of this Division.
 - 1.25.2. Hoisting facilities provided by the General Contractor may be available for Subcontractor's use. If the General Contractor's hoisting facilities are inadequate, provide hoisting facilities for the Work of this Division. Coordinate requirements with the General Contractor prior to submission of Bid.
- 1.26. ENCLOSURES
 - 1.26.1. Where VFDs, pump control panels, fan control panels, or disconnect switches supplied by Mechanical are installed in parking garages, bike storage spaces, or spaces accessible to the public or general building occupants, install the aforementioned items inside a secured, lockable, naturally ventilated, see through tamperproof cover. Ensure tamperproof cover is such that Electrical Code "working space around electrical equipment" with secure footing requirements are complied with.
- 1.27. INTELLECTUAL PROPERTY
 - 1.27.1. The Contractor acknowledges, represents, warrants and agrees that the Owner, its Consultants, and the Engineer's Representative are not responsible, and are hereby indemnified against any action as a result of patent infringement made through the review, acceptance, or receipt of materials, equipment, Work, etc. provided by the Contractor or any of their Suppliers or manufacturers in the execution of this Contract.

1.28. CYBER SECURITY

1.28.1. Coordinate with Owner's Information Technology representatives, obtain a copy of Owner's cyber security policy and provide all applicable cyber security configurations.

1.28.2. Definitions

- .1 Cyber Assets: Systems (including hardware, software, and data) and communication networks (including hardware, software, and data).
- .2 Critical Cyber Assets: Cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.
- .3 Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.
- .4 Cybercrime: Any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.
- .5 Cyber Hygiene: Practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.
- .6 Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.
- .7 Cyber Security: Technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.
- .8 Cyber Threat or Cyber Security Threat: Malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS / DoS) attacks and other attack vectors.
- .9 Cyber Threat Actors: Broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber Security awareness, and technological developments to gain unauthorized access to information systems in order to access or otherwise affect victims' data, devices, systems and networks.
- .10 IP Multicast: Technique for one-to-many and many-to-many real-time communication over an IP Infrastructure network.
- .11 Endpoint: Remote computing device that communicates back and forth with a network to which it is connected. Such as a server, desktop, or laptop.
- .12 Network Certificates: Also known as a Digital Certificates, which are an electronic "password" that allows a person or organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:
 - .1 Secure Socket Layer Certificate (SSL) Digi-SSL
 - .2 Software Signing (Code Signing Certificate) Digi-Code
 - .3 Client Certificate (Digital ID) Digi-ID
- .13 Social Engineering: Exploitation methods that target human vulnerabilities, such as carelessness and trust.
- .14 Technical Vulnerabilities: Weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.

1.28.3. Cyber Security Measures

- .1 Implement at minimum the following multi-layered Cyber Security measures to limit and / or reduce the Owner's potential risk from a cyber threat event; such as a Cyber Security data breach or Cyber Security attack.
- .2 Password Management
 - .1 Employ password management best practices such as:
 - .1 Do not use default passwords.
 - .2 Use strong and unique passwords for all applications. Use a minimum of 8 characters where there is no password policy inherent in the software; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ?]).
 - .3 Reset passwords at regular intervals.
 - .4 Configure two-factor authentication for all accounts where possible in the system software.
 - .5 Do not use System Admin logins for simple tasks; create separate User accounts with rights levels appropriate for the job function. Create and define user accounts as appropriate such as Role based, Individual logins or assigned roles.
 - .6 Use different passwords for every account.
 - .7 Enforce secure password policies within the business environment.
 - .8 Have interface lock after a predefined # of failed login attempts for a predetermined time interval.
- .3 Port and Interface Management
 - .1 Employ Port Management techniques such as:
 - .1 Restrict access on network switch ports to assigned devices addresses.
 - .2 Lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.
 - .3 Shut off all unused communication services and hardware interfaces.
 - .4 Advise Owner on use of 3rd party port security monitoring.
- .4 Physical and Virtual Networks
 - .1 Provide a dedicated VLAN for network connected systems where a dedicated LAN has not been provided.
- .5 Encryption
 - .1 Use minimum TLS 1.2 for all network attached equipment and use TLS 1.3 where available.
- .6 Network Certificates
 - .1 Ensure Network Certificates are up to date and not expired for all equipment and systems.
- .7 Firmware & Software Update Management
 - .1 Use the latest stable Firmware / Software version on all devices / equipment as well as implement a Firmware / Software Update management process and procedure.
- .8 Manufacturer's System Hardening Guides
 - .1 Provide the Manufacturer's System hardening guides for the equipment being installed and implement as many recommendations / features as possible.
- .9 External Memory

- .1 Restrict the use of external memory. Restrict or eliminate the use of devices such as external USB Thumb drives unless expressly allowed by the Owner's Information Technology representatives.
- .10 Log Off
 - .1 Enable auto-log off timer for all software, websites and logins. Set auto-log off timer on local Workstation(s) being used to access the equipment with a reasonable timer in the case that an employee leaves the workstation unattended.
- .11 Anti-Virus Software
 - .1 Enable and configure anti-virus software on PC endpoints in accordance with the Owner's Information Technology requirements, unless it is to be installed and configured by the Owner.
- .12 Filtering Techniques
 - .1 Apply filtering techniques including the types listed below where possible:
 - .1 Web Filtering: A Web filter adds another layer to anti-phishing defences by blocking the web-based component of phishing and malware attacks.
 - .2 Multicast Message Filtering: Filters the packets sent to multicast groups users are not subscribed to.
 - .3 Content Filtering: Is the use of a program to screen and / or exclude access to web pages or email deemed objectionable. A content filter will then block access to this content.
- .13 Back up Regularly
 - 1. Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible.
 - 2. Identify files that require manual backup and the backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.
- 1.28.4. IT Devices and Systems
 - .1 Apply the Cyber security measures listed in the clauses above in part or in full, as possible, to a wide range of Information Technology (IT) Devices including:
 - .1 Firewalls
 - .2 Routers
 - .3 Network switches (Core and Edge Devices)
 - .4 Servers and databases
 - .5 Workstation computers
 - .6 Network connected system devices and controllers
 - .7 Wireless Access Points and wireless controllers
 - .8 Mobile phones and tablets
 - .9 Any IT System or endpoint connected to the network
- 1.28.5. Operational Technology (OT) Devices and Systems
 - .1 Apply the Cyber security measures listed in the clauses above, in part or in full, as possible, to a wide range of OT Network devices including:
 - .1 Industrial Control Systems such as:

- .1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.
 - .2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.
 - .3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.
 - .4 (CNC) Computer numerical Control is the automated control of machining tools (Drills, boring tools, lathes) and 3D printers by means of a computer.
 - .2 Building Management Systems (BMS) and Building Automation Systems (BAS)
 - .3 HVAC equipment
 - .4 Lighting controls for both internal and external applications
 - .5 Energy monitoring and metering equipment
 - .6 Transportation and parking systems
 - .7 Scientific equipment
 - .8 Any other OT System or endpoint that can be connected to the network
- 1.28.6. Report Cybercrime
- .1 Advise the Owner and / or their representatives of any indication of a Cyber Incident of a criminal nature when performing any work on a network connected system.
- 1.28.7. Cyber Security Report Letter
- .1 Provide a Cyber Security Report Letter in the closeout documents to the client stating which Cyber Security measures have been implemented, when implementing any and / or all of the Cyber Security Measures mentioned in this Specification.
- 1.29. WARRANTY
- 1.29.1. Except where longer warranty periods are required by other specification sections, provide a one (1) year warranty for the Work, starting at Substantial Performance of the Work.
- 1.29.2. Coordinate the extension of manufacturer warranties to comply with the clause above, based on the duration of construction.
- 1.30. LIFE SAFETY INTEGRATION TESTING
- 1.30.1. Provide testing of the integration of all life safety and fire protection systems.
- 1.30.2. The Integrated Testing Coordinator (ITC) will complete an Integration Testing Plan (ITP). Carry out the testing as described by the ITC in the ITP, and in accordance with CAN/ULC-S1001 "Integrated Systems Testing of Fire Protection and Life Safety Systems" as it relates to any mechanical systems.
- 1.30.3. The ITC and development of the ITP are not the responsibility of this Contractor.
- 1.30.4. The testing of the integrated systems shall include, but not be limited to the following systems and all associated components:
- .1 Fire Alarm (e.g. mechanical systems integrated with or controlled by fire alarm system – dampers, fan start up, fan shut down, make up air, pressurization, etc.)
 - .2 Elevators

- .3 Emergency Generators and/or Inverters (e.g. combustion air, cooling air, cooling, dampers, fuel, alarms, etc.)
- .4 Sprinkler Systems
- .5 Standpipe Systems
- .6 Fire Pumps
- .7 Water Supplies
- .8 Water Supply Control Valves
- .9 Heat Tracing for Life Safety Systems
- .10 Fixed Fire Suppression Systems
- .11 Cooking Equipment Fire Suppression Systems
- .12 Automatic Door Operators for Stair Relief
- .13 Hold-Open Devices (e.g. smoke control system integration)
- .14 Smoke Control Systems (Passive and / or Active)
- .15 Venting to Aid Firefighting
- .16 Hazardous Protection Monitoring
- .17 Gas / CO Detection Systems
- .18 Prevention of Smoke Recirculation (AHUs)
- 1.30.5. Coordinate with all other trades to carry out the appropriate testing.
- 1.30.6. Be responsible for carrying out and coordinating the testing Work associated with the ITP. Coordinate all Work with the ITC and include but not be limited to the following:
 - .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
 - .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
 - .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001.
 - .4 Provide all other documentation requested by the ITC as it relates to the mechanical systems in conformance with CAN/ULC-S1001.
- 1.31. VALUATION OF CHANGES
- 1.31.1. Further to Contract requirements, use the following method in determining the value of a change to the Work, by either Change Order or Change Directive:
 - .1 Estimate and acceptance in a lump sum, unless the Engineer's Representative otherwise determines that the method shall be unit prices set out in the Contract.
- 1.31.2. Provide the Engineer's Representative with a detailed cost analysis of the proposed change including:
 - .1 Quantity of each material.
 - .2 Unit cost of each material.
 - .3 Labour units based on Mechanical Contractors Association of America (MCAA) Labour Estimating Manual.
 - .4 Labour (hours) involved.

- .5 Suppliers' quotation or credit memo for equipment noted in proposed change, with detailed breakdown.
 - .6 Sub-trade quotations including a complete cost breakdown of the proposed change meeting the requirements of this section.
 - .7 Sub-trade's suppliers' quotation or credit memo for equipment noted in proposed change, with detailed breakdown.
 - .8 Mark-ups, if applicable.
 - .9 Value of GST or HST, as applicable.
 - .10 Proposed change in contract time, if any.
 - .11 S+A proposed change number in every quotation to facilitate record keeping.
- 1.31.3. Comply with requirements of Contract Documents for all materials included in quotations for proposed changes.
- 1.31.4. List material and labour separately for each item/clause of the proposed change, on the detailed cost breakdown.
- 1.31.5. Not be entitled to any additional compensation arising out of changes to the Work other than the amounts determined and agreed to under CCDC 2-2020 GC 6.2.
- 1.31.6. Inform the Surety Company or Companies who have issued any bonds for this Contract, and any Insurers who have insured any part of the Work or operations or who have an interest in this Contract, of all changes in the Contract. Pay all costs of any changes in bonds or insurances required to maintain bonds or insurances in conformance with the requirements of the Contract Documents. Provide Owner immediately with any revised bonds or insurances.
- 1.31.7. Charge special equipment rental rates at cost. Provide an official quotation of the equipment rental with the proposed change quotation as backup, otherwise special equipment rentals will not be accepted by the Owner/Consultant.
- 1.31.8. The maximum percentage fee for mark-ups is as stated in the Division 0/1 specifications or Contract Supplementary Conditions.
- 1.31.9. All changes, change notices, proposed changes, revisions to contract, Supplemental Instructions, Change Directives or any additional costs or deletes to the stipulated lump sum Contract Price are subject to review and scrutiny by a qualified third party or individual.
- 1.31.10. Use material costs based on a discount to nationally available pricing guides (i.e. Trade Service, Allpriser, etc.) to reflect a value with a fair and reasonable markup to the actual cost of the materials purchased from distributors. The Owner and/or Engineer's Representative reserve the right to negotiate material pricing to a value that is fair and reasonable to the Owner. Indicate on the Bid Form or Supplementary Bid Form: which pricing guide is proposed to be used and discount rate compared to list price.
- 1.31.11. Base the hourly labour rate for all changes on a Journeyperson rate as listed on the Bid Form and/or Supplementary Bid Form. The Owner and/or Engineer's Representative reserve the right to renegotiate the labour rate. The hourly labour rate will be inclusive of overhead, markup and profit.
- 1.31.12. At the request of the Owner or the Engineer's Representative, submit a detailed labour cost breakdown showing a breakdown of all adders to the base wage rate to show how the Contractor has come to the proposed hourly rate. The Owner and the Engineer's Representative reserve the right to negotiate the hourly labour rate with the Contractor.
- 1.31.13. When pricing additional work for proposed changes, only price new materials that are required for the proposed change. Where existing materials and/or infrastructure can be re-used for the proposed change, utilize these items in the valuation of the change at no extra cost.

- 1.31.14. Where a proposed change includes both credits and extras, overhead and permitted mark-ups apply to the net extra or credits, if any, of the entire change.
- 1.31.15. When pricing proposed changes containing both additions and credits, and where no work and/or materials have been installed on site, only price the net new materials and net new labour that are required for the proposed change. Utilize equal per unit labour and material costs for credits and additions.
- 1.31.16. Utilize equal per unit labour and material costs for credits and additions.
- 1.32. STATEMENT OF PRICES
 - 1.32.1. To form a basis for progress payments, submit a sample progress draw for the various portions of the work. Provide sample progress draw format matching that shown in the example progress draw below. As part of the sample progress draw, include a breakdown which illustrates all categories shown on the example progress draw which are relevant to the project. Break down the categories to clearly illustrate the value of the material being supplied as the first subcategory and the value of the labour being supplied as the second subcategory, as shown on the example progress draw. Provide further material and labour breakdowns by floor, area, or phase if the project sequencing or schedule focuses on distinct areas, one at a time. The Engineer's Representative reserves the right to request that additional categories be added to the progress draw if the Engineer's Representative feels that doing so will aid in assessing the Contractor's progress on site, thereby expediting Contractor payment. Progress draws not including the categories shown on the example progress draw where relevant to the project and / or not providing separate labour value and separate material value subcategories will be rejected.
 - 1.32.2. Ensure that the total price of all portions of the work equals the total price of the work covered under the Mechanical Division. Present cost for as-built drawings and O&M manuals as separate line items as shown below. Present line items from Section 20 08 00.00 – COMMISSIONING as shown below.
 - 1.32.3. List and track each of the approved changes on separate lines on the progress draw.
 - 1.32.4. Provide progress draw where the amount claimed is for the value, proportionate to the amount of the Contract, of Work performed and Products delivered to the Place of the Work as of the last day of the payment period. Do not include items on the progress draw which don't meet these conditions.
 - 1.32.5. Amortize costs of temporary facilities and utilities over the duration of the Work. Claims for 'mobilization,' 'bidding costs,' or similar lump sums at or before start of Work are not acceptable.

EXAMPLE PROGRESS DRAW
Mechanical Contractor Name
Billing Application Mechanical Division
Project Name

Application Number – xx

Date – xxxx to xxxx

<u>Description</u>	<u>Contract Value</u>	<u>%</u>	<u>Billed To Date</u>	<u>%</u>	<u>Prev. Billed</u>	<u>%</u>	<u>This Billing</u>	<u>Balance to Complete</u>
Permits	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Demolition & removals	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing piping – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing piping – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing fixtures – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing fixtures – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing equipment – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Drainage piping – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Drainage piping – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Drainage pumps – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Drainage pumps – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire protection piping – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire protection piping – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire protection valves / equipment – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire protection valves / equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC piping – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC piping – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC ductwork – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC ductwork – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC equipment – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
HVAC equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Building Automation System raceways and wiring – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Building Automation System raceways and wiring – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Building Automation System equipment – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Building Automation System equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Heat tracing – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Heat tracing – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Gas service – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx

Gas service – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Gas piping – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Gas piping – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Water service – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Water service – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fuel oil system – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fuel oil system – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Excavation and backfill – Materials	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Excavation and backfill – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Balancing Contractor walk-through of site with Mechanical Contractor to confirm that all valves, appurtenances, dampers, and balancing devices to fully balance and test the systems are available and accessible	x,xxx.xx	xxx	x,xxx.xx	xxx	x,xxx.xx	xxx	x,xxx.xx	x,xxx.xx
Shop Drawings (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Installation review and equipment verification (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Plumbing and drainage system testing (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Testing of piping systems (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Assistance with Independent Contractor balancing of piping systems (0.25 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Testing of air systems (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Assistance with Independent Contractor balancing of air systems (0.25 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
System start-up (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Commissioning / Testing (3% of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Operating & Maintenance Manuals (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Training (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
As-Built Drawings (0.5 % of contract value)	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Demobilization / Clean-up	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	Xxx	xxx,xxx.xx	xxx,xxx.xx
Subtotal	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Additions to Contract								
CO # / PC # / CCN #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx

Cash Allowance #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
	-----		-----		-----		-----	-----
Subtotal	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
	-----		-----		-----		-----	-----
Total Contract	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Less Holdback			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	
			-----		-----		-----	
Total			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	

2. Products

2.1. NOT USED

3. Execution

3.1. NOT USED

END OF SECTION

20 05 01.00 Abbreviations

1. General

1.1. ABBREVIATIONS

- 1.1.1. The following list of common abbreviations and acronyms may be utilized in the Contract Documents or in the execution of the Work. The list is considered general in nature and all abbreviations or acronyms identified may not apply to the specific Work required to be completed. The list is not exhaustive and some abbreviations or acronyms may be the same however represent different denotation (e.g. BHP - Boiler Horsepower and BHP - Brake Horsepower) and must be read in the context of the Section the abbreviation or acronym is written in. A Section may define alternative abbreviations or acronyms that take precedence in the execution of the Work of that Section.

AABC	- Associated Air Balance Council
AAP	- Alarm Annunciator Panel
ABMA	- American Boiler Manufacturers Association
ABSA	Alberta Boilers Safety Association
AC	- Alternating Current
ACO	- Acid Resistant Cleanout
AD	- Acid Resistant Drains
AFD	- Acid Resistant Floor Drain
AFF	- Above Finished Floor
AGA	- American Gas Association
AMCA	- Air Movement and Control Association
ANSI	- American National Standards Institute
AHRI	- Air-Conditioning, Heating and Refrigeration Institute
ASCE	- American Society of Civil Engineers
ASHRAE	- American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	- American Society of Mechanical Engineers
ASTM	- American Society for Testing and Materials
AV	- Acid Resistant Vent
AWG	- American Wire Gauge
AWS	- American Welding Society
AWWA	- American Water Works Association
BHP	- Boiler Horsepower or Brake Horsepower
Btu/hr	- British Thermal Units per Hour
BWG	- British Wire Gauge
CAD	- Computer Aided Drafting
CAFV	- Controllable Air Flow Venturis
CAP	- College of American Pathologists
CBC	- California Building Code
CCA	- Chromated Copper Arsenate
CEMA	- Canadian Electrical Manufacturer's Association
CEMS	- Central Energy Management System

CCF	- Central Computer Facility
CCMC	- Canadian Construction Materials Centre
cfm	- Cubic Feet per Minute
CGA	- Canadian Gas Association
CGSB	- Canadian General Standards Board
CI	- Cast Iron
CIMJ	- Cast Iron Mechanical Joint
CPU	- Central Processing Unit
CRN	- Canadian Registration Number
CSA	- Canadian Standards Association
cu.ft.	- Cubic Feet
cu.m.	- Cubic Meter
c/w	- Complete with
db.	- Dry Bulb
dB	- Decibel
dBA	- A-weighted Decibel
DC	- Direct Current
DDC	- Direct Digital Control
DegC	- Degrees Celsius
DegF	- Degree Fahrenheit
dia.	- Diameter
DPDT	- Double Pull Double Throw
DPTX	- Differential Pressure Transmitters
EAP	- Excess Exhaust Alarm Panel
EDR	- Equivalent Direct Radiation
EF	- Exhaust Fan
EEMAC	- Electrical Equipment Manufacturers Association of Canada
EEPROM	- Electrically Erasable Programmable Read-Only Memory
EMT	- Electrical Metallic Tubing
EP	- Electric Pneumatic
EPDM	- Ethylene Propylene Diene-Rubber
EPROM	- Electrically Programmable Read Only Memory
ERW	- Electric Resistance Welded
FACP	- Fire Alarm Control Panel
FDA	- Food and Drug Administration
FHC	- Fume Hood Controller or Firehose Cabinet
FLA	- Full Load Amps
fpm	- Feet per Minute
fps	- Feet per Second
FM	- Factory Mutual
ft.	- Foot or Feet
ga	- Gauge
gal	- Gallons

GFD	- Gallons per Square Feet per Day
GPD	- Gallons per Day
GPH	- Gallons per Hour
GPM	- Gallons per Minute
GS	- Galvanized Steel
GSG	- Galvanized Sheet Gauge
GSS	- Galvanized Sheet Steel
h-cu.ft.	- Hour-cubic footHCFCs - Hydrochlorofluorocarbons
HEPA	- High Efficiency Particulate Air
HOA	- Hand/Off/Auto
HOT	- Hand Held Operator Terminal
HSS	- Hollow Steel Sections or Hollow Structural Sections
HTK	- Hood Termination Kit
hp	- High Pressure or Motor Horsepower
Hz	- Hertz
IAO	- Insurers' Advisory Organization
IAOC	- Insurers' Advisory Organization of Canada
IBC	- International Building Code
ICU	- Intensive Care Unit
(I)GPH	- (Imperial) Gallons per Hour
(I)GPM	- (Imperial) Gallons per Minute
in.	- Inch or Inches
in. WG	- Inches of Water Gauge
IRMA	- Inverted Roof Membrane Assembly
kg	- Kilogram
kg/cu.m.	- Kilogram per cubic meter
kPa	- Kilopascals
kVa	- Kilovolt-amps
kW	- Kilowatts
lbs/cu.ft.	- Pounds per cubic foot
lbs/hr.	- Pounds per Hour
L	- Litre
L/s	- Litres per Second
LFC	- Laminar Flow Cabinets
LEDs	- Light Emitting Diodes
LCP	- Laboratory Control Panel
LTF	- Linear foot
LM	- Linear meter
mA	- Milliamps
MAC	- Make-up Air Controller
mADC	- Milliamps Direct Circuit
MBH	- 1000 British Thermal Units per Hour
MCC	- Motor Control Centre

mm	-	Millimetre
m	-	Metre
m/s	-	Metres per Second
mL	-	Millilitre
MCP	-	Motor Control Panel
MJ	-	Mechanical Joint
MOV	-	Motor Overvoltage
mPa	-	Millipascals
MSC	-	Master Summing Controller
MSG	-	Manufacturers' Standard Gauge
NADCA	-	National Air Duct Cleaners Association
NBS	-	National Bureau of Standards
NC	-	Noise Criterion as Defined by Graph in ASHRAE
NCCLS	-	National Committee for Clinical Laboratory Standard
NEMA	-	National Electrical Manufacturers Association
NFPA	-	National Fire Protection Association
NIM	-	Network Interface Module
NIST	-	National Institute of Standards and Technology
NIOSH	-	National Institute of Occupancy Safety and Health
NPS	-	American National Standard Straight Pipe Thread
NPSH	-	Net Positive Suction Head
NPT	-	American National Standard Taper Pipe Thread
No.	-	Number
NST	-	National Standard Thread
NVLAP	-	National Voluntary Laboratory Accreditation Program
OAT	-	Outside Air Temperature
OC	-	On Centre
OCP	-	Operator Control Panel
OPSS	-	Ontario Provincial Standard Specification
OS&Y	-	Outside Screw and Yoke
OWRA	-	Ontario Water Resources Act
oz.	-	Ounce or Ounces
PCU	-	Personal Computer Unit
PE	-	Pneumatic Electric
PIT	-	Portable Interface Terminal
ph	-	Hydrogen Ion Concentration
ppm	-	Part per Million
psf	-	Pounds per Square Foot
psi	-	Pounds per Square Inch
psia	-	Pounds per Square Inch Absolute
psig	-	Pounds per Square Inch Gauge
PWM	-	Pulse Width Modulation
PVC	-	Polyvinyl Chloride

qt.	- Quart
RAH	- Return Air Humidity
RH	- Relative Humidity
RO	- Reverse Osmosis
rpm	- Revolutions per Minute
RPU	- Remote Processing Unit
RPU-TU	- Remote Processing Unit for Terminal Units
SCFH	- Standard Cubic Feet per Hour
SCMH	- Standard Cubic Meters per Hour
SCR	- Silicone Controlled Rectifier
SI	- International System of Units
SMACNA	- Sheet Metal and Air Conditioning Contractors' National Association
sp. in. wg.	- Static Pressure, Inches Water Gauge
SPDT	- Single Pull Double Throw
SPS	- Sash Position Sensor
SS	- Stainless Steel
SF	- Supply Fan
SPWM	- Sine-Coded Pulse Width Modulated
SSPC	- Steel Structures Painting Council (The Society of Protective Coatings)
sq.m.	- Square Meter
STC	- Supply/Exhaust Tracking Controller or Sound Transmission Class
SWS	- Sidewall Velocity Sensors
TDS	- Totally Dissolved Solids
TEFC	- Totally Enclosed Fan Cooled
TIG	- Tungsten Inert Gas
TKV-TWA	- Threshold Limit Value - Time Weighted Average
UACU	- Unitary Air Conditioning Units
UL	- Underwriter's Laboratories
ULC	- Underwriter's Laboratories of Canada
Ohm	- Ohm
USP	- United States Pharmacopeia
USG	- United States Gallons
USGPH	- United States Gallons per Hour
USGPM	- United States Gallons per Minute
UV	- Ultraviolet
VAC	- Volts Alternating Current
VDC	- Volts Direct Current
VFD	- Variable Frequency Drive
VSC	- Variable Speed Controllers
VSCFH	- Closed Loop Variable Frequency Drives For Dedicated Exhaust Hoods
VSD	- Variable Speed Drives
W	- Watt
W/cu.m.	- Watts per Cubic Meter

W/ft.	- Watts per Foot
W/m	- Watts per Meter
W/sq.in.	- Watts per Square Inch
W/sq.m.	- Watts per Square Meter
WC	- Water Closet
wb	- Wet Bulb
wg	- Water Gauge
WHMIS	- Workplace Hazardous Material Information System
WSP	- Working Steam Pressure
WOG	- Water, Oil, Gas

2. Products

2.1. NOT USED

3. Execution

3.1. NOT USED

END OF SECTION

20 05 02.00 As-built drawings

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. RELATED WORK SPECIFIED ELSEWHERE
 - 1.2.1. Refer to as-built drawings in Section 01 70 00.00 (01 72 29.00) - CLOSEOUT SUBMITTALS.
 - 1.3. RECORD OF REVISIONS ON SITE
 - 1.3.1. Print and maintain two complete sets of white prints to mark the Project progress, changes and deviations.
 - 1.3.2. Maintain an updated copy of plans and schematics in the digital format for which the Project is provided (i.e. AutoCAD or Autodesk Revit MEP) and be capable to produce documents in Adobe PDF upon request.
 - 1.4. SUBMITTALS
 - 1.4.1. Submit as-built drawings in Revit/CAD format and PDF format for underground services for review prior to slab pour.
 - 1.4.2. Submit as-built drawings in Revit/CAD format and PDF format for all other areas of the building prior to request for occupancy.
 - 1.4.3. Comply with Section 20 05 03.00 - SHOP DRAWINGS for all submittals.
 - 1.5. WARRANTY
 - 1.5.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
 - 2.1. NOT USED
3. Execution
 - 3.1. DOCUMENTATION REQUIREMENTS
 - 3.1.1. As the Project progresses record all changes and deviations.
 - 3.1.2. Maintain an accurate dimensional record of revisions. Specifically record:
 - .1 Underground piping invert elevations and pipe locations dimensioned to column lines after review and acceptance by the Authority Having Jurisdiction.
 - .2 Inverts of underground piping at building exit and entry, below floor slab at each branch connection, riser base, and change in direction as well as a least 3 points on long straight runs.

- .3 Above ground piping revisions.
- .4 Duct revisions.
- .5 Equipment revisions.
- .6 Locations of access doors and panels. Identify the equipment and components they serve.
- .7 Locations of valves.
- 3.1.3. Keep revisions up-to-date during construction including Change Orders, Change Directives, and Supplemental Instructions. Make documentation available for review at all times.
- 3.1.4. Final as-built documents shall not contain markings or corrections electronically or by hand (i.e. marker, pen, pencil, etc.). Drawings submitted that contain mark-ups will not be accepted.
- 3.2. SUBMISSION REQUIREMENTS
 - 3.2.1. On completion of the Work, submit the draft documentation indicating all such changes and deviations for review by the Engineer's Representative. Submit all documents in PDF format.
 - 3.2.2. Upon return of the "Reviewed" draft submittal, transfer "as-built" information and any additional submittal comments to the final software submission requirement (i.e. Autodesk AutoCAD or Autodesk Revit MEP).
 - .1 Request the acceptable version(s) of the software that may be used. Owner shall confirm the acceptable software version upon receipt of request. If the Owner has no preference, the latest published version shall apply.
 - .2 Conform to the Owner/Engineer's Representative's standards.
 - .3 The Mechanical Contractor may request from the Engineer's Representative the most current electronic documentation (Mechanical Drawings) in AutoCAD. Documents to be forwarded via a secure file transfer. The Engineer's Representative will provide the Drawings one time at no charge. Where the Drawings are requested more than one time throughout the course of the project, a nominal charge of \$500.00 will apply to the second and subsequent requests.
 - .4 Clearly label electronic files with Engineer's Representative and Owner, Contract number, file names and the Drawing number.
 - 3.2.3. Submit the documents in PDF along with the submission of the completed electronic source software documentation on an approved electronic storage device for review by the Engineer's Representative.
 - 3.2.4. If required, the Engineer's Representative will provide a quotation to this Contractor to transfer "as-built" information from the mark-up documentation to the acceptable software.
 - .1 Include a cost of \$400.00 per sheet for the transfer of marked up "as-built" information to AutoCAD and forwarding of the mechanical information by the Engineer's Representative to the Owner.
 - 3.2.5. The Project will remain incomplete and monies retained until a satisfactory as-built submission is provided.
- 3.3. AUTOCAD SPECIFIC SUBMISSION REQUIREMENTS
 - 3.3.1. Submit a complete list of layer names and brief description of each layer's use with all files.
 - 3.3.2. Submit a complete list of symbol (block) names with a description of each symbol.
 - 3.3.3. Make special effort to ensure that drafting is accurate, i.e. appropriate lines are indeed horizontal and vertical; lines that should intersect do but not over-intersect and that entities are placed on correct layers.

- 3.3.4. Use the standard fonts available in the software. Do not use custom fonts, shape files, etc.
- 3.3.5. Provide all drawings in the same scale of measurement and units as issued on Bid Documents.

END OF SECTION

20 05 03.00 Shop Drawings

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. RELATED WORK SPECIFIED ELSEWHERE
 - 1.2.1. Comply with Section 01 33 00.00 (01 33 23.00) for Submittals except as amended below.
2. Products
 - 2.1. SHOP DRAWINGS
 - 2.1.1. Submit Shop Drawings organized by Specification Section. Ensure Shop Drawing package for a given Specification Section is complete, including all equipment, products, materials, and systems to be used as part of that Specification Section, and submit as a single shop drawing package. Do not submit numerous separate Shop Drawings for the same Specification Section. Do not combine more than one Specification Section into one submission. Incorrect submissions will be returned without review.
 - 2.1.2. Within three (3) weeks of Project award, submit the following as the first Shop Drawing/Submittal:
 - .1 A list of the Shop Drawings/Submittals that are proposed to be submitted for the Project, taking into account the organizational requirements of the clause above. Order the list based on Specification Section number, from lowest to highest. Follow the format shown in the example below and use the headings shown to produce a table.
 - .2 State expected equipment lead times.
 - .3 State estimated submission date for Shop Drawings/Submittals.

Example Proposed Shop Drawing List

Mechanical Contractor Name

Project Name

<u>Specification Section #</u>	<u>Specification Section Name</u>	<u>Item</u>	<u>Expected Equipment Lead Time</u>	<u>Estimated Submission Date</u>

- 2.1.3. Do NOT submit all Shop Drawings/Submittals for the Project at the same time. If large quantities of Shop Drawing/Submittals are received at the same time, the Consultant will not be able to review them all within the normal time frame and will require the Contractor to identify the priority order in which submissions should be reviewed.
- 2.1.4. Submit Shop Drawings electronically, by email, in PDF format. Submissions that are not electronic without prior approval from the Engineer's Representative shall be returned as not reviewed. Provide the following information in the email submission:
 - .1 S+A Project number and Contractor Shop Drawing Identifier in Subject Line

- .2 Attachments shall be limited to 20 MB
- .3 Provide FTP hyperlink for all attachments in excess of 20 MB with appropriate information for downloading the file (as required)
- .4 Shop Drawing Submission to the following email address:
 - .1 ContractAdmin.Toronto@smithandandersen.com
- 2.1.5. Shop drawings submitted directly to Smith + Andersen personnel (and not copied to the email address provided above) without advanced permission will not be processed nor considered as received.
- 2.1.6. Shop Drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each Shop Drawing shall give the identifying number as noted in the documents of the specific pump, fan, etc. for which it was prepared.
- 2.1.7. Each Shop Drawing for non-catalogue items shall be prepared specifically for this Project. Shop Drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.
- 2.1.8. When requested, Shop Drawings shall be supplemented by data explaining the theory of operation. The Engineer's Representative may also request that this information be added to the maintenance and operating manual.
- 2.1.9. Provide a cover sheet with the Project name, issue date, issue number, Specification section number, title of section and with space for Shop Drawing review stamps for the Contractor and Engineer's Representative.
- 2.2. ENVIRONMENTAL PRODUCT DECLARATIONS (EPD)
 - 2.2.1. Where EPDs are available for Products, submit them for review.
 - 2.2.2. Follow Product Category Rules (PCRs) for Life Cycle Assessment (LCA) presented on EPDs.
 - 2.2.3. Where multiple EPDs are available for the same Product, the order of preference is as follows:
 - .1 Product Specific, Facility Specific EPD: a Product and manufacturer specific EPD, where the environmental impacts are unique to the specific manufacturing facility.
 - .2 Product Specific EPD: a Product and manufacturer specific EPD where the environmental impacts are considered across multiple manufacturing facilities (i.e. an average of the different facilities in which the Product is manufactured).
 - .3 Industry Average EPD: an EPD for a type of Product, representing the typical environmental impacts averaged across a number of different manufacturers.
- 3. Execution
 - 3.1. SUBMISSIONS
 - 3.1.1. Each Shop Drawing or catalogue sheet shall be in original PDF format stamped and signed by the Contractor to indicate that they have checked the submission for conformance with all requirements of the Drawings and Specifications, that they have co-ordinated this equipment with other equipment to which it is attached and/or connected and that they have verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the Work of other trades. Ensure that electrical co-ordination is complete before submitting Shop Drawings for review.
 - 3.1.2. Scanned PDF versions are not acceptable.

- 3.1.3. Manufacturing of equipment, installation of equipment or connecting services shall not start until after final review of Shop Drawings by the Engineer's Representative has been completed.
- 3.1.4. Should equipment or materials that arrive on site differ from those shown on the Shop Drawings, bear all costs for:
 - .1 Revising the equipment and materials.
 - .2 Revising the Work of other Contractors impacted.

END OF SECTION

20 05 05.00 Selective Demolition for Mechanical Services

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. These Specifications are an integral part of the Contract Documents and apply to all Division 20, 21, 22 and 23 Sections.

1.1.3. Provide labour, materials, products, equipment and services required to complete the decommissioning and/or demolition Work specified herein.

1.1.4. Refer to Drawings for extent of decommissioning and/or demolition Work. The Drawings indicate the approximate locations of services as far as these are known. The Drawings do not necessarily represent the full extent of the installed service(s) to be removed and are inferred to include decommissioning of all pipes, valves, fittings, appurtenances, etc. except where a service or component is explicitly identified to remain as an abandoned service.

.1 For decommissioning and demolition of all services within a floor or identified area, refer to as-built drawings for reference for additional detail as required.

.2 Where full removal of services or equipment is required and existing as-built drawings are not available, review the service locations on site, plan the removal to avoid disruption or accidental discharge from services, and mark all services for demolition with colour coding as required for phased removal.

1.1.5. Dispose of all debris offsite in accordance with the jurisdictional authorities.

1.1.6. Remove and pay for the disposal of refrigerants, oils, glycol, or similar materials in accordance with all municipal by-law or code requirements.

1.1.7. Remove and store salvageable items as directed herein or indicated on Drawings.

1.1.8. Mechanical decommissioning and/or demolition Work associated with this building is indicated on the Mechanical Drawings and generally consists of the following:

.1 HVAC systems including all ducts, pipes, controls, and appurtenances.

.2 Plumbing and drainage including all sanitary, storm, venting, water distribution, natural gas distribution, specialty piping such as compressed air, fuel oil, etc.

.3 All fire protection systems including sprinkler systems, standpipe systems, fire hose cabinets and all appurtenances.

.4 Remove services in a staged or phased approach to allow for immediate repair or service replacement where required to temporarily maintain the integrity of the building envelope against weather, etc.

1.2. REFERENCE STANDARDS

1.2.1. Meet the requirements of all Municipal, Provincial and Federal By-laws and Ordinances for the Province and Municipality for the Place of the Work.

1.2.2. Execute this Work in accordance with the latest or in force edition of the following codes and standards:

.1 Ontario Building Code.

.3 Occupational Health and Safety Act.

.4 Regulations for Construction Projects.

- .5 Ontario Fire Code.
- .6 National Fire Code of Canada.
- .8 Regulations under Fire Protection and Prevention Act.
- .9 Technical Standards and Safety Authority (TSSA).

1.3. SUBMITTALS

- 1.3.1. Submit Shop Drawings as requested by the Engineer's Representative, indicating demolition sequence, cutting and patching, bracing and protection of existing services designated to remain.
- 1.3.2. Comply with Section 01 33 00.00 (01 33 23.00) for Submittals except as amended below.
- 1.3.3. Comply with Section 20 05 03.00 – SHOP DRAWINGS.

1.4. QUALITY ASSURANCE

- 1.4.1. Provide adequate equipment and skilled labour with appropriate certifications suitable to the demolition task.
- 1.4.2. Remove from site and dispose of debris, refrigerants, oils, etc. in accordance with the requirements of the Authority Having Jurisdiction.
- 1.4.3. Arrange and pay for all permits, notices and inspections necessary for the proper execution and completion of the demolition Work.
- 1.4.4. Decommissioning of special equipment, where noted on the Mechanical Drawings, must be provided by the equipment manufacturer.
- 1.4.5. Review and sign off on all demolition Work prior to demobilization of demolition trades. Any associated costs due to failure to review and sign off on demolition Work will be the responsibility of the Mechanical Contractor.

2. Products

2.1. DISPOSAL OF MATERIALS

- 2.1.1. Except as required by Law for disposal, the Contractor may claim ownership of all materials which have not been designated for salvage from the demolition. Remove all material and debris from the site as quickly as possible and dispose of in a legal manner. Properly remove and dispose of all refrigerant and other toxic or hazardous materials. Burning of debris or selling of materials on site is not permitted. The Contractor is responsible for all future use (or misuse) of items once they have been removed from the installed location.
- 2.1.2. Conform to the requirements of the Municipality regarding disposal of waste materials.
- 2.1.3. Materials prohibited from municipality waste management facilities shall be removed from site and disposed to recycling companies specializing in recyclable materials.

2.2. SALVAGEABLE ITEMS TO BE REMOVED AND STORED

- 2.2.1. The following is a list of salvageable items to be carefully disconnected, removed and turned over for storage for future use:
 - .1 NONE.

3. Execution

3.1. GENERAL INSTRUCTIONS

- 3.1.1. At the end of each Work shift, leave Work in a safe condition.
- 3.1.2. Demolish Work into sections of practical size for removal without alteration or damage to existing building structure or finishes that are indicated to remain.
- 3.1.3. Demolish Work in sections, replacing with new materials as required, for services to remain in operation during the demolition and construction process. This may include, but is not limited to systems such as storm drainage, sanitary drainage, etc.

3.2. STORAGE OF MATERIALS

- 3.2.1. Store materials only in areas designated and as permitted by the local jurisdictional authorities.
- 3.2.2. Do not stack materials and debris in the building to the extent that overloading of any part of the structure will occur.

3.3. PROTECTION OF PREMISES

- 3.3.1. Adhere strictly to the Owner's requirements.
- 3.3.2. Adhere strictly to the requirements for heritage preservation.
- 3.3.3. Adhere to an agreed upon schedule for dust and noise control prior to commencing Work in or adjacent to existing facilities where such Work might affect other facilities or their occupants.
- 3.3.4. Execute Work with least possible interference or disturbance to the building occupants, public, and normal use of adjacent premises.
- 3.3.5. Provide temporary means to maintain security when security has been reduced by this Contractor.
- 3.3.6. Utilize only elevators, dumbwaiters, conveyors or escalators assigned for Contractor's use for moving workers and material within the building. Protect walls of passenger elevators prior to use. Accept liability for damage, safety of equipment and overloading of existing equipment.
- 3.3.7. Provide temporary dust screens, barriers, warning signs in locations where renovations and alteration Work is adjacent to public areas which will be operative during Work.
- 3.3.8. Protect all heritage or other mechanical systems indicated to remain against damage.
- 3.3.9. Provide and maintain ready access to firefighting equipment at all times.
- 3.3.10. Provide and maintain proper and suitable fire extinguishers throughout the duration of the Work.
- 3.3.11. The Drawings indicate the approximate locations of services, as far as these are known. Should any mechanical or electrical service that is anticipated to remain in place (i.e. storm drainage) be broken or disrupted by operations specified under this contract, repair the service and make good all damage. Temporarily remove and replace all services or parts of services to permit the full removal of services identified.
- 3.3.12. The existing Drawings and/or as-built drawings indicate the approximate locations of services as far as these are known. Where specific services are identified for removal within an area of Work, immediately advise the Engineer's Representative in writing when unknown or unexpected services are encountered. Investigate and clearly document these services back to their source, as required, to facilitate further direction regarding removal.
- 3.3.13. Accept liability for costs incurred by the Owner in repairing and cleaning equipment, etc., resulting from failure to comply with the above requirements.

3.4. RESTRICTIONS REGARDING USE OF PREMISES

- 3.4.1. Use only those existing entrances and stairs designated for access to and egress from the existing buildings and various floors where Work of this contract is to be carried out. No traffic through other areas of the building will be permitted without the prior consent of the Owner.
- 3.4.2. Keep stairs and corridors clear and open as required for exit purposes in case of fire, and as required for use by the Contractor's personnel.

3.5. PREPARATION

- 3.5.1. Prior to commencing this Work, arrange to have the appropriate trades present to disconnect all utility services where required.
- 3.5.2. Drain completely all gravity or pressurized water services to avoid damage or hazard due to accidental discharge. Where sections of the installed services cannot be drained fully utilizing existing valves, drain connections, etc., open the service and control the discharge of water appropriately to avoid discharge during service removal.
- 3.5.3. Identify and protect all existing services designated to remain.

3.6. INTERRUPTION OF EXISTING SERVICES TO REMAIN

- 3.6.1. Arrange, schedule and perform Work to mitigate disturbance to existing facilities and services.
- 3.6.2. Submit a complete master schedule of anticipated service interruptions and changeovers with approximate dates required, durations and times of day, for approval by the Owner before proceeding with any Work. Update and submit the schedule on a weekly basis during construction.
- 3.6.3. Notify the Owner in writing at least 36 hours in advance (unless specified elsewhere) of the planned interruption of existing services that are to remain.
- 3.6.4. Interruption of services must occur at the times and for the duration stipulated by the Owner.
- 3.6.5. Keep service interruption duration to an absolute minimum. Carry out all preparatory Work, measurements, etc., without interruption of existing services where possible.
- 3.6.6. The following service interruptions are required to be performed after business hours or on weekends, etc. Include all required costs to complete the Work during this time:
 - .1 Sprinkler Work

3.7. PARTIAL REMOVAL OF A SERVICE

- 3.7.1. Remove services back to the main (service pipe or duct) or nearest branch (pipe or duct) serving other areas to remain. Cap services tight to the main or branch.
- 3.7.2. Do not abandon unused services in the ceiling space, furred walls, shafts, etc. unless expressly permitted by the Engineer's Representative or Owner.
- 3.7.3. Where an unused service is indicated or permitted to remain, mark the abandoned services clearly including the service type (i.e. Do Not Connect - Abandoned Chilled Water).

END OF SECTION

20 05 13.00 Electric Motors

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Provide electric motors for all driven equipment supplied by this Division.

1.2. SUBMITTALS

1.2.1. Provide Shop Drawings for all electrical motors in accordance with Section 20 05 03.00 - SHOP DRAWINGS and incorporate the following information:

- .1 Horsepower
- .2 Voltage
- .3 Frequency
- .4 Speed
- .5 Starting current and torque characteristics
- .6 Full load current
- .7 Class of insulation
- .8 Enclosure type
- .9 Service factor
- .10 Ambient temperature reference
- .11 Type of bearings
- .12 Locations of connection box
- .13 Manufacturer
- .14 Motor starting times

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Motors:

- .1 Efficiency:
 - .1 Meet or exceed requirements of ASHRAE 90.1 “Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings,” CSA C390 “Test method, marking requirements, and energy efficiency levels for three-phase induction motors,” and Government of Canada Electric Motors Energy Efficiency Regulations.

- .2 High efficiency motors: T frame, AC, three phase, meeting or exceeding the CSA C390 "Test Methods, Marking Requirements, and Energy Efficiency Levels for Three-phase Induction Motors" Table 3 Premium Efficiency levels and approved under the Canadian Electrical Code:
 - .1 Provide high efficiency motors for all fans and pumps having motors 0.75 kW (1 hp) or larger.
 - .2 Squirrel cage induction type with standard drip proof enclosure.
 - .3 Conform to NEMA and CSA standards for electrical motors.
 - .4 Canadian manufacturer where possible.
 - .5 1750 nominal rpm unless specified otherwise.
 - .6 Class F Insulation system.
 - .7 For motors controlled by variable speed drives, provide a class F insulation system and comply with NEMA MG 1 "Motors and Generators" Part 31 "Definite Purpose Inverter-fed Polyphase Motors."
 - .8 Starting current-torque characteristics in accordance with NEMA, Design B unless otherwise specified or unless load characteristics dictate otherwise.
 - .9 Starting times: start and accelerate to full speed within 10 seconds.
 - .10 Motor horsepowers indicated in the Specifications, Schedules, or Drawings are minimums.
 - .11 Designed for continuous operation at 40 deg. C. (104 deg. F.).
- 2.1.2. Motors controlled from Variable Speed Drives:
- .1 Maintenance free, conductive microfiber, shaft grounding ring.
 - .1 AEGIS SGR for low voltage motors up to 500 hp.
 - .2 AEGIS Pro Series for medium and low voltage motors over 500 hp.
 - .3 Where explosion proof motors are required, locate shaft grounding rings within explosion proof enclosure in accordance with IEEE Standard 303 "IEEE Recommended Practice for Auxiliary Devices for Rotating Electrical Machines in Class I, Division 2 and Zone 2 Locations" or inside the explosion proof motor. Install in accordance with manufacturer's recommendations.
- 2.1.3. Locate motor connection boxes on side of motor most easily accessible for maintenance and remote from belts, gears or driven equipment. If boxes are factory installed on wrong side of motor, relocate as required.
- 2.1.4. Motor characteristics unless noted otherwise in equipment schedules:
- .1 For 0.375 kW (1/2 hp) and larger 575 volt, 3 phase, 60 cycle.
 - .2 For 0.25 kW (1/3 hp) and smaller 120 volt, 1 phase, 60 cycle.
- 2.1.5. Single phase motors 0.25 kW (1/3 hp) and smaller: capacitor start.
- 2.1.6. Provide motors 22.4 kW (30 hp) and larger with heat detector protection embedded in the windings for connection into the motor control circuit.
- 2.1.7. Motors 74.6 kW (100 hp) and larger: suitable for reduced voltage starting, delta-wye.
- 2.1.8. Motor enclosures as follows:
- .1 If protected from the weather and entraining moisture, use open drip-proof, service factor 1.15.
 - .2 Motors located in air streams: suitable for satisfactory operation at maximum temperature and moisture levels of surrounding air.

- .3 For all other locations, use totally-enclosed fan-cooled (TEFC), service factor 1.0.
 - .4 Use explosion proof motors where scheduled.
- 2.1.9. Nameplate: minimum of 2 mm (3/32 in.) thick laminated phenolic plastic 100 mm (4 in.) long x 50 mm (2 in.) wide with black face and white centre, 5 mm (7/32 in.) high letters engraved through to the white lamination, securely fastened in a conspicuous place on the motor. Include the following information on the nameplate:
 - .1 Motor No.
 - .2 Mechanical Equipment Driven
 - .3 Circuit No.
 - .4 Panel No.
 - .5 Panel Location
- 2.1.10. Manufacturer nameplate: include the nominal full load motor efficiency.
- 2.1.11. Manufacturers:
 - .1 Canadian General Electric
 - .2 TECO Westinghouse
 - .3 Lincoln
 - .4 US Motors
 - .5 Weg
 - .6 ABB Baldor
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Install protective guards over all moving parts. Include tachometer holes for each shaft.
- 3.1.2. Check that all motors are rotating in the correct direction. Where they are not, work with the Electrical Contractor to resolve the motor rotation issue.

END OF SECTION

20 05 14.00 Wiring and Starters

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. All power and control wiring from starters and fused and non-fused disconnect switches, whether mounted in MCCs or individually, to all mechanical devices and equipment shall be provided by this Division except where shown and specified under the Electrical Division.

1.1.3. All starters for devices supplied by this Division shall be provided by this Division except where shown and specified under the Electrical Division.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. All power wiring and starters for devices supplied by this Division shall be provided by the Electrical Division except where shown and specified under this Division. All control wiring shall be provided by this Division.

1.2.2. Where starters for skid mounted, packaged equipment are provided by this division they shall meet the requirements of the Electrical Division.

1.3. REFERENCES

1.3.1. IEC 60947-4-1 "Low-voltage switchgear and controlgear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters" latest edition.

1.3.2. CSA C22.2 No. 60947-4-1 "Low-voltage switchgear and controlgear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters (Bi-national standard with UL 60947-4-1)" latest edition.

1.3.3. CSA C22.2 No. 4 "Enclosed and dead-front switches (Tri-national standard with NMX-J-162-ANCE-2016 and UL 98)" latest edition.

1.3.4. CSA C22.2 No. 39 "Fuseholder assemblies" latest edition.

1.4. SUBMITTALS

1.4.1. Further to the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and Section 20 05 03.00 - SHOP DRAWINGS, submit Shop Drawings of the following for Individual Starters:

- .1 Submit an overload thermal element list with all supporting data for review prior to installation of the elements.
- .2 Submit samples of nameplates for review before manufacturing.
- .3 Mounting method and dimensions.
- .4 Starter size and type.
- .5 Layout of identified internal and front panel components.
- .6 Enclosure types.
- .7 Wiring diagram for each type of starter.
- .8 Interconnection diagrams.

- 1.4.2. Further to the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and Section 20 05 03.00 - SHOP DRAWINGS, submit Shop Drawings of the following for Motor Control Centre:
- .1 Outline dimensions.
 - .2 Configuration of identified compartments.
 - .3 Floor anchoring method and dimensioned foundation template.
 - .4 Cable entry and exit locations.
 - .5 Dimensioned, position and size of busbars and details of provision for future extension.
 - .6 Schematic and wiring diagrams.
 - .7 Size, capacity and labeling of all starters.
 - .8 Electrical ratings of MCC.
- 1.5. WARRANTY
- 1.5.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
- 2.1. DISCONNECT SWITCHES
- 2.1.1. Fusible, horsepower rated disconnect switch in CSA Type 3R enclosure, size as indicated.
- 2.1.2. Provision for padlocking in on-off switch position by three locks.
- 2.1.3. Mechanically interlocked door to prevent opening when handle in ON position.
- 2.1.4. Fuses: size as indicated, class J, current limiting, in accordance with Section 26 28 14.00 - FUSES - LOW VOLTAGE.
- 2.1.5. Fuse-holders: suitable without adaptors, for type and size of fuse indicated.
- 2.1.6. Quick-make, quick-break action.
- 2.1.7. ON-OFF switch position indication on switch enclosure cover.
- 2.1.8. Equipment identification
- .1 Provide equipment identification in accordance with Section 26 05 53.00 - IDENTIFICATION.
 - .2 Indicate name of load controlled on nameplate.
 - .3 Provide a lamacoid nameplate that indicates the replacement fuse size as well as the maximum allowable fuse size for that disconnect switch based upon the sizing of the feeder.
- 2.1.9. MANUFACTURERS
- .1 Schneider Electric.
 - .2 Eaton Cutler-Hammer.
 - .3 Siemens.
- 2.2. MOTOR CONTROL CENTRE
- 2.2.1. SUPPLY CHARACTERISTICS
- .1 600 V, 60 Hz, wye connected, 3 phase, 3 wire, plus bonding conductor.

2.2.2. GENERAL DESCRIPTION

- .1 Compartmentalized vertical sections with common power busbars.
- .2 Floor mounting, free standing, metal enclosed dead front enclosure.
- .3 Indoor CSA Type 1 with drip hood, sprinkler proof enclosure suitable for front mounting.
- .4 Class I Type C wiring.

2.2.3. VERTICAL SECTION CONSTRUCTION

- .1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form a rigid, completely enclosed assembly.
- .2 Each vertical section shall be divided into compartment units.
- .3 Each unit to have complete top and bottom steel plate for isolation.
- .4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel barriers.
- .5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.
- .6 Openings, with removable cover plates, in side of vertical sections for horizontal wiring between sections.
- .7 Incoming cables to enter at top or bottom as indicated on Drawings.
- .8 Provision for outgoing cables to exit via top or bottom with terminals.
- .9 Removable lifting means.
- .10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.
- .11 Divide assembly for shipment to site, as required complete with hardware and instructions for re-assembly.

2.2.4. SILLS

- .1 Continuous 50 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.2.5. BUSBARS

- .1 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment bare self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:
 - .1 Main horizontal busbars rated as specified on MCC schedules, but no less than 600 A.
 - .2 Branch vertical busbars as required to meet the connected load and 20% spare capacity (300 A minimum).
- .2 Branch vertical busbars for distribution of power to units in vertical sections.
- .3 No other cables, wires, equipment in main and branch busbar compartments.
- .4 Brace buswork to withstand effects of short-circuit current of 65 kA RMS symmetrical.
- .5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.2.6. GROUND BUS

- .1 Copper ground bus extending entire width of motor control centre.
- .2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

2.2.7. MOTOR STARTERS AND DEVICES

- .1 Refer to Section 26 29 00.00 - MOTOR STARTERS TO 600 V and to Motor Control Schedule.

2.2.8. STARTER UNIT COMPARTMENTS

- .1 Units NEMA size 5 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.
- .2 Unit mounting:
 - .1 Engaged position - unit stabbed into vertical bus.
 - .2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.
 - .3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.
 - .4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.
- .3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.
- .4 Hinge unit doors on same side.
- .5 Overload relays manually reset from front with door closed.
- .6 Pushbuttons and indicating lights mounted on door front.
- .7 Devices and components by one manufacturer to facilitate maintenance.
- .8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.

2.2.9. FINISHES

- .1 Equipment to be painted: baked grey enamel.

2.2.10. MANUFACTURERS

- .1 Schneider.
- .2 Eaton.
- .3 Siemens.
- .4 Rockwell Automation Allen-Bradley.

- 2.2.11. Provide an engraved lamaroid nameplate for the motor control centre and each individual starter within the motor control centre. MCC identification shall be 50 mm (2 in.) high letters. All other identification shall be 6 mm (1/4 in.) high letters.

Typical Identification Plate for Motor Control Centre

First Line	-	MCC #1
Second Line	-	Voltage/Phase/# of Wires
Third Line	-	Fed from main secondary switchboard
Fourth Line	-	In main electrical room

Typical Identification Plate for Individual Starters

First Line	-	Supply Fan SF-1

Second Line - Voltage/Phase/# of Wires

2.2.12. All nameplates shall be fastened with self-tapping screws.

2.3. MATERIALS

2.3.1. Starters: to IEC 60947-4-1 with AC4 utilization category.

2.4. EQUIPMENT

2.4.1. All starters (with the exception of manual motor starters) are to be combination starters with fusible disconnect switches.

.1 All fusible disconnects are:

- .1 To be of the quick make and quick break type.
- .2 To have an operating handle on the outside of the enclosure.
- .3 To have fuse clips suitable for HRC type J fuses.

.2 The operating handle of the fusible disconnect switch must be:

- .1 Capable of being locked in the "OFF" position.
- .2 Have provisions of accepting 3 pad locks.
- .3 Have provision for preventing switching to "ON" position while enclosure door is open.

2.4.2. All starters, with the exception of manual motor starters, are to be provided with a single phase, dry type control circuit transformer with:

- .1 A fused secondary.
- .2 Primary voltage as indicated.
- .3 120 V secondary.
- .4 Secondary fusing.

2.4.3. Size the control transformer for control circuit load plus 20 % spare capacity, minimum capacity 150 VA.

2.4.4. All starters shall be equipped with indicating lamps that are long life cluster LED style.

2.4.5. All starters shall be provided with 3 phase bimetallic overload relays which are adjustable and are ambient temperature compensated. Manual resets for the overload relays are to be mounted on the enclosure door such that they can be reset from outside of the enclosure and have externally visible trip indication.

2.4.6. All starters shall have identification for each wire and terminal for external connection, within starter, with permanent number marking identical to diagram.

2.5. MANUAL MOTOR STARTERS

2.5.1. Single or three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

- .1 Switching mechanism, quick make and break.
- .2 One overload heater per phase, manual reset, trip indicating handle.

2.5.2. Accessories:

- .1 Toggle switch: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating light: oil tight type and colour as indicated on the Starter Schedule.

- .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.6. FULL VOLTAGE MAGNETIC STARTERS

- 2.6.1. Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

- .1 Contactor solenoid operated rapid action type.
- .2 Motor overload bimetallic protective relay.
- .3 Wiring and schematic diagram inside starter enclosure in a visible location.

- 2.6.2. Accessories:

- .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating lights: oil tight type and color as indicated on the Starter Schedule.
- .3 2-N/C and 2 N/O spare auxiliary contacts unless otherwise indicated on the Starter Schedule.

2.7. FULL VOLTAGE REVERSING MAGNETIC STARTERS

- 2.7.1. Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

- .1 Two - 3 pole magnetic contactors mounted on a common base.
- .2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.
- .3 Motor overload bimetallic protective relay.
- .4 Wiring and schematic diagram inside starter enclosure in a visible location.

- 2.7.2. Accessories

- .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating lights: heavy duty oil tight type and color as indicated on the Starter Schedule.
- .3 Auxiliary control devices as indicated on the Starter Schedule.

2.8. MULTI-SPEED STARTERS

- 2.8.1. (2) Speed starters of size, type, rating and enclosure type as indicated. Starter suitable for variable torque type motor, unless otherwise indicated, 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 re-connectable winding for consequent pole type motors.
- .3 Three overload relays.

- 2.8.2. Accessories:

- .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating lights: heavy duty oil tight, type and color as indicated on the Starter Schedule.
- .3 Auxiliary control devices as indicated on the Starter Schedule.

- .4 Low speed compelling relay and automatic sequence accelerating, decelerating relays for each speed.

2.9. MAGNETIC STARTER, REDUCED VOLTAGE, AUTO-TRANSFORMER

2.9.1. Auto-transformer starter closed circuit transition type, of size, type, rating and enclosure type as indicated and with following components:

- .1 Three 3-pole contactors.
- .2 Auto-transformer with 50 %, 65 % and 80 % taps.
- .3 One adjustable pneumatic timing relay.
- .4 One 3-pole manual reset overload device.
- .5 Thermal overload protection of auto-transformers.

2.9.2. Accessories:

- .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating lights: heavy duty oil tight type and color as indicated on the Starter Schedule.
- .3 Auxiliary control devices as indicated on the Starter Schedule.

2.10. MAGNETIC STARTER REDUCED VOLTAGE STAR-DELTA

2.10.1. Reduced voltage star-delta open transition starter, of size, type, rating and enclosure type as indicated, with components 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 the star contactor.
- .4 One timing relay.
- .5 Three overload relays.

2.10.2. Reduced voltage star-delta closed transition starter, of size, type, rating and enclosure type as indicated, with components 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 the star contactor.
- .6 One timing relay.
- .7 Three overload relays.

2.10.3. Accessories:

- .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating lights: heavy duty oil tight, type and color as indicated on the Starter Schedule.
- .3 Auxiliary control devices as indicated on the Starter Schedule.

2.11. MAGNETIC STARTER REDUCED VOLTAGE PART WINDING

2.11.1. Two-step reduced voltage, part winding starter of size, type, rating and enclosure type as indicated, with components as follows:

- .1 Two 3-pole contactors.
- .2 Adjustable pneumatic timer.
- .3 Six manual reset overload relays.

2.11.2. Three step reduced voltage part winding starter of size, type, rating and enclosure type as indicated, with the following components:

- .1 Three 3-pole contactors.
- .2 One set starting resistors.
- .3 Six overload relays.

2.11.3. Accessories:

- .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating lights: heavy duty oil tight type and color as indicated on the Starter Schedule.
- .3 Auxiliary control devices as indicated on the Starter Schedule.

2.12. THREE PHASE MANUAL REVERSING STARTER

2.12.1. Three phase manual reversing starter of size, type, rating and enclosure type as indicated, with components as follows:

- .1 Two 3-pole manual motor starters, quick make and break.
- .2 Six overload relays and manual reset.
- .3 Mechanical interlock to prevent both switches from closing at same time.

2.12.2. Accessories

- .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating lights: heavy duty oil tight type and colour as indicated on the Starter Schedule.

2.13. THREE PHASE MANUAL TWO SPEED SEPARATE WINDING STARTERS

2.13.1. Three phase manual two speed separate winding starters of size, type, rating and enclosure type as indicated with components as follows:

- .1 Two 3-pole manual motor starters, quick make and break.
- .2 Six overload relays and manual reset.
- .3 Mechanical interlock to prevent both switches from closing at same time.

2.13.2. Accessories:

- .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating lights: heavy duty oil tight type and colour as indicated on the Starter Schedule.

2.14. ENCLOSURE

- 2.14.1. Starter to come in a CSA Type 3R enclosure, size as indicated.
- 2.14.2. Equipment to be painted: baked grey enamel.
- 2.14.3. Provide an engraved lamacoid nameplate for each individual starter. Identification shall be 6 mm (1/4 in.) high letters.

Typical Identification Plate

- First Line - Exhaust Fan EF-1
- Second Line - 208 V/3 ph./3 W
- Third Line - Fed from splitter #1

3. Execution

3.1. INSTALLATION

- 3.1.1. Install starters, connect power to starter and provide wiring from starter to motor through a manual disconnecting device if required by code.
- 3.1.2. Connect controls to starters and connect power to controls.
- 3.1.3. Ensure correct fuses and overload devices elements installed.
- 3.1.4. All wiring and starters provided by this Division shall comply with the requirements of the Electrical Division of the Specifications.
- 3.1.5. This Division shall review the Shop Drawings for the motor starters submitted by the Electrical Division to ensure that all field connections are shown, the motor horsepower are correct and that the motor control schematics reflect all requirements.
- 3.1.6. Install disconnect switches in accessible locations which meet the electrical code requirements for working space with secure footing. Working space clearance envelope to be 1 m deep in front of disconnect switch, 1 m or disconnect switch width wide, whichever is greater, and 2.2 m high.
- 3.1.7. Ensure slack is provided in control wiring connections to control valves, dampers, differential pressure sensors, or other equipment with moving parts.
- 3.1.8. Ensure slack is provided in power wiring connections to control valves, dampers, differential pressure sensors, or other equipment with moving parts.

3.2. FIELD QUALITY CONTROL

- 3.2.1. Perform tests in accordance with Section 26 08 01.00 - TECHNICAL SERVICES DIVISION START-UP SERVICE and manufacturer's written instructions. Contractor to oversee all testing and correct any deficiencies noted.
- 3.2.2. Operate switches, contactors to verify correct functioning.
- 3.2.3. Perform starting and stopping sequences of contactors and relays.
- 3.2.4. Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

20 05 15.00 Variable Frequency Drives

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. QUALITY ASSURANCE

1.2.1. The Variable Frequency Drive (VFD) manufacturing facility shall be ISO 9001 "Quality Management Systems - Requirements" certified. The VFD shall be UL listed, Canadian UL listed and CSA listed.

1.2.2. Provide a minimum 100,000 hours mean time between failure (MTBF).

1.2.3. The term Variable Frequency Drive (VFD) shall be synonymous with Variable Speed Drives (VSD) and Adjustable Frequency Drives (AFD).

1.2.4. All Variable Frequency Drives for this Project shall be of a single manufacturer for all fan and pump systems, including all components that require VFDs for air handling equipment, cooling towers, fluid coolers, pumps, etc. except where specifically identified as part of a packaged system in these Specifications.

1.3. RELATED WORK

1.3.1. For motors connected to Variable Frequency Drives, refer to requirements of Section 20 05 13.00 - ELECTRIC MOTORS.

1.4. SUBMITTALS

1.4.1. Submit Shop Drawings of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.4.2. Ensure Shop Drawings include VFD Short Circuit Current Rating (SCCR).

1.5. WARRANTY

1.5.1. Provide 24-month warranty starting at the date of Substantial Performance of the Work. Provide warranty that includes on-site parts and labour.

2. Products

2.1. GENERAL REQUIREMENTS

2.1.1. Variable Frequency Drives (VFD) shall be Danfoss VLT HVAC Drive FC102, Rockwell Automation Allen-Bradley PowerFlex 700, and ABB ACH580 as specified herein for the fans, pumps, heat recovery wheels, and cooling tower fans designated on the schedules or in the respective sections to be variable speed.

2.1.2. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. The VFD's UL listing shall allow it to be mounted in a plenum or other air handling compartments.

- 2.1.3. For indoor applications, the VFD shall be housed in a CSA Type 1 with drip hood, sprinkler proof enclosure.
- 2.1.4. For outdoor and humid (>70 % relative humidity) applications, the VFD shall be housed in a CSA Type 3R enclosure.
- 2.1.5. The VFD shall be a digitally controlled drive, using Pulse Width Modulation (PWM) technology with sensorless vector control. It shall utilize IGBTs in its inverter section.
- 2.1.6. The VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor when the motor's rated voltage is applied to the VFD input.
- 2.1.7. The VFD shall include an integral disconnect switch on the line side of the drive.
- 2.1.8. VFD shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be **10,000 A**. Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.
- 2.1.9. The VFD including all specified options shall be assembled by the ANSI/UL Standard 508 "Industrial Control Equipment" certified manufacturer for the building and assembly of option panels and the complete unit shall be tested to ANSI/UL Standard 508. Assembly of the option panels by a third-party panel shop shall not be acceptable. Where the components are separate, the appropriate CSA or C-UL stickers shall be applied to both the VFD and option panel. Both the VFD and option panel shall be manufactured in ISO 9001 "Quality Management Systems - Requirements" certified facilities.
- 2.1.10. Provide harmonic filters for VFDs in accordance with Section 20 35 26.00 – HARMONIC FILTERS.
- 2.1.11. The VFD's full load amp rating shall meet or exceed Canadian Electrical Code Table 44 "Three-phase ac motors." The VFD shall be able to provide full rated output current continuously, 110 % of rated current for 60 seconds and 160 % of rated current for up to 0.5 second while starting.
- 2.1.12. The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.
- 2.1.13. Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output. Disconnect switches located between the drive and the motor shall be interlocked into the VFD's safety circuitry.
- 2.1.14. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.
- 2.1.15. VFD power components shall be designed for 600 V AC where intended for 575/600 V service. Components designed for 480 V AC installed on 575/600 V service shall not be acceptable.
- 2.1.16. VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.
- 2.1.17. VFD's output switching shall be maintained within the requirements of NEMA Standard MG 1 "Motors and Generators" Part 30. VFD's with output exceeding 1000 V shall employ dV/dT output filters.

2.2. PROTECTIVE FEATURES

- 2.2.1. A minimum of Class 20 I²t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.
- 2.2.2. Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over-voltage, under-voltage, VFD over-temperature and motor over-temperature. The VFD shall display all faults in plain English. Codes shall not be acceptable.
- 2.2.3. Where the Electrical Drawings indicate that the VFDs are to be used on a high resistance grounded (HRG) power distribution system, as is common in hospitals, data centres, and industrial facilities, ensure that VFD surge protection devices are of the delta connected type, and ensure that metal oxide varistor (MOV) maximum continuous operating voltage (MCOV) is selected for a HRG power distribution system of the voltage shown on the Electrical Drawings. Ensure that MOVs will not fail when a sustained line-to-ground fault occurs on the HRG system and the two unfaulted phases see their line-to-ground voltage rise to the line-to-line voltage until the Owner undertakes a scheduled shutdown at a later time. Ensure that the remainder of the VFD components are selected for proper application on a HRG system.
- 2.2.4. Protect the VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90 % of the nominal.
- 2.2.5. The VFD assembly including all required options shall be rated for 100,000 A interrupting capacity (AIC).
- 2.2.6. The VFD shall have built-in or externally mounted EMI electromagnetic filters to limit the EMI and RFI output from the VFD, designed to meet standard EN/IEC 61800-3 "Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods."
- 2.2.7. The VFD shall have a wide operating supply power range and shall continue to operate without faulting or tripping until the input voltage reaches at least 701 V AC on 600 V systems and 300 V AC on 208/230 V systems and 539 V AC on 460 V systems.

2.3. INTERFACE FEATURES

- 2.3.1. Each VFD shall have the same operator's keypad, including digital display with Hand/Start, Off/Stop, Auto/Start, and Help selector switches or buttons that shall be provided to start and stop the VFD and determine the speed reference. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings. The keypad shall include a built-in real time clock with date function. Speed Transfer between Hand and Auto shall be "bumpless."
- 2.3.2. Each VFD shall include an open system communication protocol interface, BACnet as defined by ANSI/ASHRAE Standard 135 "BACnet™--A Data Communication Protocol for Building Automation and Control Networks" for seamless integration with Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- 2.3.3. Run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
- 2.3.4. The VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.
- 2.3.5. If the temperature of the VFD's heat sink rises to 80 Deg. C. (176 Deg. C.), the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD's heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.

- 2.3.6. At least six programmable digital inputs shall be provided for interfacing with the system's control and safety interlock circuitry.
- 2.3.7. As a minimum, the following hardware points shall be available for direct connection to Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS):
- .1 VFD Start/Stop
 - .2 VFD Speed Control
 - .3 VFD Speed Feedback
- 2.3.8. Under smoke control or special fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed or bypass, and be capable of accepting a start and stop signal from the building's fire alarm system.
- 2.4. SERVICE CONDITIONS
- 2.4.1. Ambient temperature, -10 Deg. C. to 40 Deg. C. (14 Deg. F. to 104 Deg. F.) without derating.
- 2.4.2. 0 to 95 % relative humidity, non-condensing.
- 2.4.3. Elevation to 1005 m (3300 ft.) without derating.
- 2.4.4. AC line voltage variation, -10 to +10% of nominal with full output.
- 2.4.5. No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.
- 2.5. BYPASS
- 2.5.1. Supply either a manual 3 contactor bypass as per Article 2.5.2 or supply an electronic bypass system as per Article 2.5.3 and all respective Sub-Articles.
- 2.5.2. Provide a manual 3-contactor bypass, were indicated in schedules or specified, consisting of a door interlocked main fused disconnect switch padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/BYPASS/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed from the AC power line and power is disconnected from the VFD so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power while power is applied to the input of the VFD. This allows the VFD to be given an operational test while continuing to run the motor at full speed in bypass. In case of an external safety fault, a customer supplied normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode. Supply VFD specific only fuses.
- .1 Service personnel shall be able to defeat the main power disconnect switch and open the bypass enclosure without disconnecting power. This shall be accomplished through the use of a specially designed tool and mechanism while meeting all local and national code requirements for safety.
- 2.5.3. Provide a complete factory wired and tested electronic bypass system, consisting of an output contactor and bypass contactor. Overload protection shall be provided in both drive and bypass modes.
- .1 Include a door interlocked, padlockable circuit breaker or disconnect switch to disconnect all input power to the drive and bypass system.
 - .2 Supply fast acting fuses exclusive to and in front of the VFD only.
 - .3 The electronic bypass shall have its own keypad with, Drive, Bypass, Hand, Off, Auto, Reset operator keys.

- .4 The keypad shall also have the following LED indication: Ready, Enable, Drive running, Bypass running, Drive fault, Bypass fault, Bypass H-O-A mode, Auto transfer to bypass selected, Drive selected, Bypass selected.
 - .5 All external safety interlocks shall remain fully functional whether the system is in Hand, Auto or Bypass modes.
 - .6 The electronic bypass shall be fully operable from the Serial Communications system which shall have capability to monitor the VFD/Bypass mode, check status of H-O-A, Bypass fault, and Override and also force the motor into Bypass mode.
- 2.5.4. Bypass shall be provided on the systems:
- .1
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Comply with manufacturer's installation instructions.
 - 3.1.2. Provide a disconnect switch at the motor where required by the authorities having jurisdiction. Where such a disconnect switch is installed, provide an auxiliary contact or switch at the disconnect switch, mounted to open when the disconnect switch is opened and wired to a terminal strip in the VFD such that opening the disconnect switch initiates a drive shut down and prevents the drive from starting in either Line or Drive positions.
 - 3.1.3. Locate and mount VFD panels in Mechanical Rooms and/or where shown on the Drawings.
 - 3.1.4. Where VFDs are shown on the Drawings in locations away from building walls or need to be installed away from building walls, install them in accordance with the Execution requirements of Section 20 05 29.00 – HANGERS AND SUPPORTS.
 - 3.1.5. Arrange for manufacturer's technical representative or local qualified representative to:
 - .1 Inspect the installation of the drives and to start-up.
 - .2 Test and commission the drives. The VFD shall operate a dynamometer at full load and speed and shall be cycled during the test.
 - .3 Be present during testing and commissioning performed under Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
 - 3.1.6. Measure the distortion of each phase at the load terminals of the branch breaker and report the results to the Engineer's Representative. Any deficiency shall be corrected and re-evaluated.
 - 3.1.7. Implement a communication protocol for remote interface to match the communication protocol under Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
 - 3.1.8. BAS connection to drives provided under Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).

END OF SECTION

20 05 19.00 Indicating Instruments

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Shop Drawings: Further to requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and Section 20 05 03.00 - SHOP DRAWINGS, submit working ranges of thermometers and gauges with Shop Drawings.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Pipeline thermometers shall be complete with:

- .1 Dust-tight stainless case and stem with 127 mm (5 in.) dial.
- .2 Bi-metal type.
- .3 White face with black lettering.
- .4 Range normally 0 to 115 deg. C. (32 to 240 deg. F.) for hot water and -17 to 49 deg. C. (0 to 120 deg. F.) for chilled water but range shall suit maximum and minimum temperatures of location and be shown on Shop Drawings.
- .5 Temperature marking in 1 deg. C. (2 deg. F.) increments in both imperial and metric scales.
- .6 External recalibration adjustment.
- .7 Separable socket with extension neck as required for insulated pipe.
- .8 Universal adjustable hinge.
- .9 Wells shall be registered with the provincial Boiler and Pressure Vessel Safety Branch and have a CRN.

2.1.2. For ducts up to 750 mm (30 in.) in the largest dimension, thermometers shall be similar to pipeline thermometers but with an additional perforated bulb guard and shall be flanged for mounting on ducts.

2.1.3. For ducts over 750 mm (30 in.) in largest dimension, thermometer shall be complete with:

- .1 115 mm (4½ in.) diameter, cast aluminum case construction.
- .2 Black pointer.
- .3 White face with black lettering.
- .4 Range normally 0 to 115 deg. C. (32 to 240 deg. F.) for heated supply air, 0 to 80 deg. C. (32 to 175 deg. F.) for cooled supply, mixed and return air and -40 to 90 deg. C. (-40

- to 195 deg. F.) for outside air but range shall suit maximum and minimum temperature of location and shall be shown on Shop Drawings.
- .5 Temperature marking in 1 deg. C. (2 deg. F.) increments in both imperial and metric scales.
 - .6 Vapour filled.
 - .7 1500 mm (60 in.) minimum length copper averaging bulb with bronze braided armour.
 - .8 Flanged for mounting on ducts.
 - .9 For insulated ducts or plenums, provide a bracket for mounting thermometer clear of insulation.
- 2.1.4. Thermometers for remote reading shall be similar to duct thermometers specified above but with armoured extension capillary and bulb with separable well for pipelines or flanged duct connection for averaging bulb, as required.
- 2.1.5. Pressure gauges shall be complete with:
- .1 Dust-tight nominal 115 mm (4½ in.) dia. case, solid front complete with back blow-out to ASME B40.100 "Pressure Gauges and Gauge Attachments", ASME B40.1 "Gauges: Pressure Indicating Dial Type — Elastic Element" Grade 2A Level Standards.
 - .2 Back-flanged where required.
 - .3 Black pointer.
 - .4 White dial with black markings.
 - .5 Dial range to cover twice the average working pressure of the equipment and shall be compound gauges on pump suction for all open systems.
 - .6 Clear lens.
 - .7 Phosphor bronze bourdon tube, silver soldered.
 - .8 Brass or stainless steel movement, bronze or nylon brushed, scale and movement mounted independent of the case.
 - .9 Brass socket.
 - .10 kPa and psi scales.
 - .11 Provincial Boiler and Pressure Vessel Safety Branches registration number.
 - .12 All wetted parts in contact with potable water systems shall be lead free.
- 2.1.6. Pressure and temperature test port:
- .1 Continuous operating temperature range of -40 Deg. C. (-40 Deg. F.) to 65.6 Deg. C. (150 Deg. F.).
 - .2 Dual self closing Nordel valves for 135 Deg. C (275 Deg. F.) intermittent maximum operating temperature.
 - .3 2758 kPa (400 psig) maximum operating pressure.
 - .4 Threaded brass or 316 stainless steel body to suit service material.
 - .5 Screwed cap and gasket with retaining strap.
 - .6 Temperature and pressure test kit in protective carrying case with 2 thermometers, 1 pressure gauge and 2 adaptors for full range of service temperatures and pressures.
- 2.1.7. Manometers shall be Magnehelic gauge type in dust free case with black pointer. Gauge range shall be 2½ times the maximum filter resistance. Case shall be suitable for duct or plenum mounting. Provide bracket for mounting gauge on insulated ducts or plenums.
- 2.1.8. Pressure and temperature test ports shall be Pete's Plug II.
- 2.1.9. Thermometers shall be Terice, Taylor, Weksler, Winters or Ashcroft.

2.1.10. Pressure gauges shall be Trerice, Ashcroft, Morrison, Winters or Weksler.

3. Execution

3.1. INSTALLATION

3.1.1. Locate all thermometers and pressure gauges so as to assure easy reading from the floor or platform.

3.1.2. Where direct reading instruments cannot be satisfactorily located use a remote instrument.

3.1.3. Locate remote instruments next to the point of the reading, on wall or structure.

3.1.4. Each remote or panel mounted instrument shall have an engraved lamacoid nameplate identifying the system and service.

3.1.5. Insert pipeline thermometer and/or pressure gauges into tanks, equipment tapings or in pipeline using screwed tees or forged steel couplings, welded into the pipe.

3.1.6. Duct thermometers shall be attached to duct using sheet metal screws through thermometer flange.

3.1.7. Provide thermometers in the following locations in pipelines:

- .1 In and out of each water coil or other coil, handling liquid, except individual reheat coils in ductwork
- .2 On each branch of 3 port control valves, excluding valves on fan coil, induction units, or individual reheat coils in ductwork
- .3 In and out of each heat exchanger, condenser, cooler or type of other heat exchanger
- .4 Each heating water return and each heating water supply for each main system
- .5 Each hot or cold water storage tank
- .6 and where specifically shown

3.1.8. As an alternative to thermometers and pressure gauges on pipeline systems, provide temperature and pressure ports in locations identified or shown on Standard Details.

3.1.9. When a common supply header provides the same temperature water to more than one coil or zone, provide a thermometer on the common header only.

3.1.10. For control valves with by-pass, locate thermometer in common pipe to allow for manual temperature control.

3.1.11. Provide thermometers in the following locations in ducts or plenums:

- .1 Upstream and downstream from each coil, spray or humidifier, except individual reheat coils in ductwork.
- .2 On each of 3 ducts or plenums at mixing dampers.
- .3 Return air from each zone.
- .4 Outside air entering air handling units.
- .5 and where specifically shown.

3.1.12. Where a common duct or plenum provides the same temperature air to many zones, provide a thermometer on the common duct only, rather than at each branch of a zone.

3.1.13. Provide test wells for thermometers where shown. Test wells shall be compatible with the thermometers used. Wells shall be registered with the applicable Provincial Authority Having Jurisdiction and have a CRN.

- 3.1.14. Provide a ball valve on the inlet to each gauge. Install a pressure snubber on any gauge installed near a pump or in any location where damping is required to prevent rapid oscillation of the pointer. When the equipment is subject to vibration, mount the gauge on adjacent wall or on a mounting plate, supported from the floor.
- 3.1.15. Provide pressure gauges in the following areas (not permitted to be pressure and temperature test ports):
 - .1 City (potable) water line where it enters the building
 - .2 In and out of each pump
 - .3 In and out of all pressure reducing valves
 - .4 Each fire standpipe at highest fire hose cabinet
 - .5 and where specifically shown
- 3.1.16. Provide pressure gauges or pressure and temperature test ports in the following areas:
 - .1 On each hot water supply and hot water return header
 - .2 Air cushion tank or expansion tank
 - .3 City (potable) water make-up line
 - .4 In and out of each heat exchanger, condenser, cooler or type of other heat exchanger
 - .5 and where specifically shown
- 3.1.17. Provide valved and capped connections for pressure gauges on each side of coils where pressure and temperature test ports are not provided.
- 3.1.18. Install manometer at each bank of filters to show the resistance to air flow through the filters. Where prefilters and final filters are mounted in a common frame it is only necessary to provide a single manometer to show the resistance across the total filter assembly. Where filters are separately mounted in individual frames provide a manometer for each set of filters.

END OF SECTION

20 05 29.00 Hangers and Supports

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. For piping and equipment provided under the Mechanical Division, provide complete with all necessary supports and hangers required for a safe and professional installation.

1.1.3. Hangers, supports, anchors, guides, and restraints shall be selected to withstand all static and dynamic loading conditions which act upon the piping system and associated equipment.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings in accordance with Section 20 05 03.00 – SHOP DRAWINGS.

1.2.2. The Mechanical Division shall prepare detailed Shop Drawings showing all anchors and guides for all systems with the potential for thermal expansion/contraction and/or loads due to weight or thrust. The drawings shall bear the signed seal of a Professional Engineer licensed to practice in the appropriate discipline and Place of the Work. The drawings shall include all details of construction, static and dynamic forces at points of attachment, etc. necessary for review and acceptance by the Project Structural Engineer's Representative. Make adjustments as necessary to satisfy the requirements of the Structural Division. No anchor points shall be permitted without reviewed Shop Drawings and, where installed prior to review, shall be removed and replaced to the satisfaction of the Engineer's Representative.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Provide hangers and supports manufactured by Anvil ASC Engineered Solutions, Taylor Pipe Supports, or E. Myatt & Co.

2.1.2. All pipe hangers and supports shall be manufactured to the latest requirements of ANSI MSS-SP-58 "Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation." Where applicable, design and manufacture of hangers and supports shall also conform to ANSI/ASME B31 "Code for Pressure Piping."

2.1.3. Pipe rolls shall have cast iron rollers, shaped to accept the outside diameter of the insulated pipe. Roll shall either rotate on a steel shaft mounted on a cast iron stand or shall roll on a cast iron bed plate.

2.1.4. Pipe slide assembly shall be manufactured to the latest requirements of ANSI MSS-SP-58. Assembly shall be complete with Carbon steel structural or fabricated tee, 100 % virgin PTFE bonded slide plates and carbon steel base.

- .1 For cold services such as cooling systems (e.g. chilled water, chilled glycol, brine, refrigerant, etc.), domestic cold water, and dual temperature systems (cooling systems and heating systems (e.g. heating glycol, heating, etc.)) to maintain the integrity of the

- insulation and vapour barrier and where slides cannot be directly welded to the pipe, provide a plain carbon steel pipe clamp to be welded to the tee support. Clamp shall be full length of tee support and shall be minimum 150 mm (6 in.) or as recommended by manufacturer for the specific pipe size.
- .2 For hot services such as heating systems (e.g. steam, steam condensate, heating glycol, heating, etc.), domestic hot water, etc. where the piping is 50 mm (2 in.) and larger, use a standard catalogue protection saddle tack welded to the pipe, which provides a space between the pipe and tee equal to the thickness of the insulation. Weld the tee to the protection saddle.
 - .3 For longitudinal movement only provide hold down lugs.
 - .4 For free movement in all directions width of slide plate base shall be sufficient for full travel.
 - .5 As an alternative to the above, for compact installations, tees may be welded to the pipe directly provided that the temperature is suitable, extended structural or fabricated tees are used, and the tee is vapour sealed at the insulation and completely insulated to prevent condensation for cold services. Provide details and obtain approval from the Engineer's Representative prior to proceeding with this arrangement.
- 2.1.6. For pipe and duct runs on the roof of the building, provide roof supports by Trikon Systems, MIRO Industries (Unistrut), Advanced Support Products Inc., or Portable Pipe Hangers Inc.
- 2.1.7. For pipe and duct runs on the roof of the building, anchor pipes and ducts to the building structure using supports by Thaler Roof Specialties or equal.
- 2.1.8. As an alternative to pipe and duct runs on the roof of the building being anchored to the building structure, provide support system design taking into account wind load review, stamped and signed by a Professional Engineer registered in the location of the Project. Provide roof supports by Trikon Systems, MIRO Industries (Unistrut), Advanced Support Products Inc., or Portable Pipe Hangers Inc.
- 2.1.9. All hangers, supports, brackets and other devices installed exterior to the building or in corrosive environments (pool mechanical rooms, pools, pool change rooms, etc.) shall be galvanized to prevent failure from environmental corrosion. If galvanized components cannot be used submit samples of proposed substitute for review prior to installation.
- 2.1.10. Provide supplemental support to minimize the risk of joint separation under high thrust conditions for large diameter no-hub cast iron fittings over 102 mm (4 in.) in accordance with the Standard Details and manufacturer's recommended installation instructions.
- .1 As an alternative to the above field devised methods and materials, provide engineered pipe and fitting restraints designed and manufactured for the specific purpose of restraining no hub cast iron pipe and fittings against separation under thrust forces equivalent to 145 kPa (50 ft) head pressure. Equal to Holdrite #117.
- 2.2. CONSTANT SUPPORT HANGERS
- 2.2.1. For piping at hanger locations where the vertical movement of the piping is 12 mm (1/2 in.) or more or where necessary to avoid the transfer of load to adjacent hangers or connected equipment, pipe hangers shall be constant support design.
- 2.2.2. The total travel for constant support hangers shall be equal to travel plus 20 %. In no case shall the difference between the actual and total travel be less than 25 mm (1 in.). The constant support hanger shall have travel scales on both sides of the support frame for inspection purposes.
- 2.2.3. Each constant support hanger shall be individually calibrated prior to shipment to support the exact loads specified.

- 2.2.4. Alloy springs shall meet the requirements of ASTM A125 "Standard Specification for Steel Springs, Helical, Heat-Treated" and shall be shot peened and examined by magnetic particle. The spring rate tolerance shall be +/- 5 %.
- 2.2.5. Constant supports shall have a wide range of load adjustability. No less than 10 % of this adjustability shall be provided either side of the calibrated load for plus or minus field adjustment. Load adjustment scale shall be provided to aid the field in accurate adjustment of loads and load adjustment shall be possible without the use of special tools and shall not impact the travel capabilities of the supports.
- 2.2.6. Constant supports shall be furnished with travel stops to prevent upward and downward movement of the hanger. The travel stops shall be factory installed so that the hanger level is at the cold position. The travel stops shall be designed to permit future re-engagement.
- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent undue stress to building structural components.
 - 3.1.2. Piping shall be supported from walls, beams, columns, and slabs using approved structural attachments. In situations where approved attachments cannot be used, alternative attachments or substructure assemblies shall receive approval prior to installation. Prior approval shall be given for any cutting or drilling of building structural steel. Damage or modification to the structure through welding, cutting, or drilling shall not be permitted if it reduces the integrity of the building structure as deemed by the Structural Engineer's Representative. It shall be the responsibility of the Mechanical Division to supply anchor bolts and base diagrams for equipment and pipe supports showing exact location of attachments.
 - 3.1.3. All drilling for hangers, rod inserts and Work of similar nature shall be done by this Division.
 - 3.1.4. Auxiliary structural members shall be provided under the Mechanical Section concerned where piping, ducts or equipment must be suspended between the joists or beams of the structure, or where required to replace individual hanger to allow for installation on new services. Auxiliary structural members shall be the same material and finish as the primary structure (i.e. prime painted, galvanized, etc.). Submit details for review as requested.
 - 3.1.5. Depending on the type of structure, hangers shall be either clamped to steel beams or joists, or attached to approved concrete inserts. Submit proposed hanger details for review and acceptance by the Structural Engineer's Representative. Make adjustments as necessary to satisfy the requirements of the Structural Division.
 - 3.1.6. For precast concrete construction, hanger rods shall pass between slabs and be supported on the slab within the topping by a 100 mm x 100 mm x 3 mm (4 in. x 4 in. x 1/8 in.) steel plate welded to the hanger rod. A lock nut threaded to the hanger rod together with a 50 mm (2 in.) minimum dia. washer shall be applied tight against the under surface of the deck to prevent rising of the hanger.
 - 3.1.7. Approved type expansion shields and bolts may be used for pipe up to 100 mm (4 in.) diameter where the presetting of concrete inserts is not practical. Submit proposed hanger details for review and acceptance by the Structural Engineer's Representative. Make adjustments as necessary to satisfy the requirements of the Structural Division.
 - 3.1.8. Suspension from metal deck shall not be allowed unless specifically accepted by the Engineer's Representative. Drawings of the proposed method of suspension must be submitted for review.

3.1.9. Hangers, hanger rods and inserts in all parking and ramp areas shall meet the requirements of CSA S413 "Parking Structures" and shall be of corrosion-resistant material or have an effective, durable corrosion resistant coating. Submit samples for approval.

3.1.10. Hanger rods shall be subject to tensile loading only. Suspended piping shall be supported by adjustable hanger rods sized as follows:

Pipe Size	Hanger Rod Diameter
50 mm (2 in.) and under	9 mm (3/8 in.)
65 mm (2-1/2 in.) and 75 mm (3 in.)	12 mm (1/2 in.)
100 mm (4 in.) and 125 mm (5 in.)	16 mm (5/8 in.)
150 mm (6 in.) to 200 mm (8 in.)	19 mm (3/4 in.)
250 mm (8 in.) to 300 mm (12 in.)	22 mm (7/8 in.)

3.1.11. Unless otherwise specified or shown, hanger spacing for all services shall be as follows:

Nominal Pipe Diameter	Maximum Span
Up to and including 38 mm (1-1/2 in.)	2.1 m (7 ft.)
50 mm (2 in.) to 125 mm (5 in.)	3 m (10 ft.)
150 mm (6 in.) and larger	4.6 m (15 ft.)

.1 For all steel piping connected to the geothermal field including all piping from the field to the heat exchangers in the Energy Transfer Stations:

Nominal Pipe Diameter	Maximum Span
Up to and including 38 mm (1-1/2 in.)	2.1 m (7 ft.)
50 mm (2 in.) to 125 mm (5 in.)	3 m (10 ft.)
150 mm (6 in.) and larger	3.5 m (11.5 ft.)

3.1.12. In addition, provide a hanger within 600 mm (2 ft.) on each side of valves, fitting or tees on pipes 38 mm (1½ in.) diameter and larger.

3.1.13. Hanger spacing for plumbing and drainage services shall be in accordance with the plumbing code or municipal by-laws as applicable.

3.1.14. Hanger spacing for fire protection services shall be in accordance with the NFPA codes.

3.1.15. All horizontal piping 50 mm (2 in.) diameter and larger shall be supported by adjustable wrought iron clevis type hangers. Smaller piping shall be supported by adjustable split ring hangers or clevis type hangers.

3.1.16. Suspending one hanger from another shall not be permitted.

3.1.17. For all heating systems piping (e.g. steam, steam condensate, heating glycol, heating, etc.) and domestic hot water piping, 50 mm (2 in.) and larger, use a standard catalogue protection saddle tack welded to the pipe, which provides a space between the pipe and hanger equal to the thickness of the insulation.

3.1.18. For all heating systems piping (e.g. steam, steam condensate, heating glycol, heating, etc.) and domestic hot water piping, 38 mm (1-1/2 in.) and smaller, use line size hangers.

- 3.1.19. For all cooling systems (e.g. chilled water, chilled glycol, brine, refrigerant, etc.) piping, domestic cold water piping, or dual cooling systems and heating systems (heating glycol, heating, etc.) piping, 25 mm (1 in.) and smaller, install a section of high density insulation complete with continuous vapour barrier between the pipe and the hanger. Refer to Section 20 07 00.00 - INSULATION.
- 3.1.20. For all cooling systems (e.g. chilled water, chilled glycol, brine, refrigerant, etc.) piping, domestic cold water piping, or dual cooling systems and heating systems (e.g. heating glycol, heating, etc.) piping, larger than 25 mm (1 in.), use a galvanized steel shield between the insulation and the hanger. Between the shield and the pipe, install a section of high density insulation complete with continuous vapour barrier. Refer to Section 20 07 00.00 - INSULATION.
- 3.1.21. For insulated ducts, ensure supports are on the outside of the insulation so as to not be directly connected to the duct creating a vapour barrier issue. Provide high density insulation in the area of the supports and spread the load.
- 3.1.22. The shield width shall be minimum 1/4 of the pipe circumference. The length and gauge shall be as follows:
- .1 150 mm (6 in.) long and 14 US gauge for pipe larger than 25 mm (1 in.) up to 50 mm (2 in.) diameter
 - .2 250 mm (10 in.) long and 12 US gauge for pipes 65 mm (2-1/2 in.) to 300 mm (12 in.) diameter
 - .3 300 mm (12 in.) long and 10 US gauge for pipes 350 mm (14 in.) to 400 mm (16 in.) diameter
- 3.1.23. Hangers and riser clamps in contact with copper pipe shall be copper coated construction or plastic coated. Taped hangers and riser clamps shall not be accepted.
- 3.1.24. Unless otherwise specified or shown, all pipes supported from below shall be mounted on pipe rolls or pipe slides.
- 3.1.25. Provide constant support hangers where shown for horizontal or vertical pipes which require vertical movement for expansion. Vertical movement shown for these hangers shall be movement either up or down. Provide hangers to allow for movement in both directions.
- 3.1.26. Unless otherwise specified or shown, vertical pipes shall be supported at least every fourth floor or every 12 m (40 ft.) maximum.
- 3.1.27. Pipe slides shall be pre-engineered type. Structural or fabricated tees shall be welded to the pipe or to the protection saddle.
- 3.1.28. Install resilient hangers in accordance with Section 20 05 48.00 - VIBRATION AND NOISE CONTROL.
- 1.1.1. Install additional seismic supports in accordance with Section 23 05 49.00 - SEISMIC FORCE RESISTING SYSTEMS.
- 3.1.29. Other means of support shall be as shown or as specified hereunder.
- 3.1.30. Provide minimum clear height of 203 mm (8 in.) under roof-mounted piping, with insulation in place, to facilitate proper roof drainage and access to roof membrane.
- 3.1.31. Provide minimum clear height under roof-mounted ductwork, with insulation in place, in compliance with SMACNA "HVAC Duct Construction Standards Metal and Flexible" Rooftop Equipment Installation section figures and Smith + Andersen Mechanical Standard Details, to facilitate proper roof drainage and access to roof membrane.

- 3.1.32. For special equipment supports refer to equipment sections. Where no support method is identified, secure wall mounted equipment to metal framing or masonry, with steel toggle or expansion fasteners, machine screws or sheet metal screws as applicable. Plastic, fibre or soft metal inserts shall not be acceptable. Wall mounted equipment shall not exceed 45.5 kg (100 lbs) in weight or 250 mm (10 in.) in depth unless reviewed or detailed by the Engineer's Representative. Where framing does not permit direct attachment, provide metal strut sub-framing or minimum 19 mm (3/4 in.) fire retardant treated plywood backboards, unpainted, attached to the framing. Provide attachments for backboards at 600 mm (24 in.) on centres with no less than 4 attachments.
- 3.1.33. Where equipment control panels, VFDs, and similar equipment are shown on the Drawings in locations away from building walls or need to be installed away from building walls, provide suitably sized, galvanized, strut channel, frame walls, securely fixed to the floor, for mounting the equipment.

END OF SECTION

20 05 33.00 Electric Tracing

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.1.2. Conform to Section 26 05 01.00 - GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - 1.2. SUBMITTALS
 - 1.2.1. Submit detailed Shop Drawings for all Products being supplied and include electric tracing cable layouts, calculations, power requirements, connection quantities and locations, and control information. Demonstrate compliance with Specification.
 - 1.2.2. Submit Shop Drawings in accordance with Section 20 05 03.00 - SHOP DRAWINGS.
 - 1.3. WARRANTY
 - 1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Electric tracing cable shall be nVent Raychem or Thermon, for 208 volt, 1 phase supply.
 - 2.1.2. Tracing cable shall be self-regulating type to CSA Standard C22.2 No. 130 "Requirements for electrical resistance trace heating and heating device sets."
 - 2.1.3. Thermostat shall be minimum 20 amp rating with fixed control point set at 4.4 deg. C. (40 deg. F.).
 - 2.1.4. Thermostat shall be minimum 20 amp rating with adjustable control from 0 deg. C. (32 deg. F.) to 49 deg. C. (120 deg. F.) with remote bulb, 3 m (10 ft.) of copper capillary. Where thermostat is mounted in conditioned areas, enclosure shall be dust and moisture resistant and where mounted in non-conditioned areas, enclosure shall be weather-proof. Thermostat shall have CSA Type 4X enclosure.
 - 2.1.5. Provide electronic controller with an alarm contact for any fire protection or life safety systems to monitor cables and de-energize cables fully during periods when ambient temperatures exceed set point. Controllers for single circuit with features as follows:
 - .1 LED window digital display of measured temperature, set points, and alarm conditions;
 - .2 LED status indicators;
 - .3 integral 30 mA ground fault protection;
 - .4 programmable temperature settings;
 - .5 current rating up to 30 A;
 - .6 alarm contacts and LED indicator;
 - .7 CSA Type 4X enclosure; and

- .8 thermistor sensor.
- 2.1.6. Provide electronic controller with an alarm contact for any gutter tracing or rain water leader applications to monitor cables and de-energize cables fully during periods when ambient temperatures exceed set point or when no precipitation is occurring. Controllers for single circuit with features as follows:
 - .1 LED window digital display of measured temperature, set points, and alarm conditions;
 - .2 LED status indicators;
 - .3 integral 30 mA ground fault protection;
 - .4 programmable temperature settings;
 - .5 remote precipitation sensor(s);
 - .6 programmable time delay to control how long heating cable remains energized after end of precipitation event;
 - .7 current rating up to 30 A;
 - .8 alarm contacts and LED indicator;
 - .9 CSA Type 4X enclosure; and
 - .10 thermistor sensor.
- 2.1.7. Contactors, where required, shall be with 120 V coil and pilot light in cover. Provide control transformer as required.
- 2.1.8. The following minimum watts/linear foot shall be maintained for pipe freeze protection applications. The table below is based on a -29 Deg. C. (-20 Deg. F.) minimum ambient temperature.

Up to and including 75 mm (3 in.) pipe	=	5 watts/ft. nominal
100 - 150 mm (4-6 in.) pipe	=	8 watts/ft. nominal
200 mm (8 in.) and 250 mm (10 in.) pipe	=	12 watts/ft. nominal
Larger than 250 mm (10 in.) pipe	=	XX watts/ft. nominal per cable and XX runs of cable
- 2.1.9. For soffit and slab heating systems, provide isometric drawings for every circuit for a complete heat tracing system.
- 2.1.10. Provide thermal insulation for pipes as specified in Section 20 07 00.00 – INSULATION.
- 2.1.11. On non-metallic (plastic) pipes the cable shall be installed using aluminum tape (AT180/AL-20L). The cable shall have an outer braid of tinned copper and an outer jacket of modified polyolefin.
- 2.1.12. Electric tracing cable for sprinkler systems shall be listed for this use. Where electric tracing cable protects branch lines, it shall be specifically listed for use on branch lines.
- 2.1.13. Include the following accessories:
 - .1 power connection and end seal kits
 - .2 splice, and tee kits
 - .3 "Electric Traced" caution labels
 - .4 aluminum tape for plastic pipe (where required)
 - .5 glass cloth adhesive tape
 - .6 contactors, relays, power distribution components

- .7 mounting clips/hardware for installation of the cables on the bottom of the slab
- 2.1.14. Internal tracing for gutters or canopy rain water leaders shall be self-regulating roof and gutter de-icing cable. Cable jacket shall be ultraviolet stabilized and weather proof. All cable components shall be UL Listed and CSA Certified for use as part of the system for keeping water drainage paths clear and to avoid ice dams. Component enclosures shall be CSA Type 4 rated. Cable shall have a nominal wattage of 5 watts/ft with a power output of 12 watts/ft in snow and ice.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Completely cover the pipe with cable for the full length shown, and without gaps. Ensure that valve body and bonnet are completely protected.
- 3.1.2. Install heating cables after pipe installation and testing is complete. Attach cable as recommended by the manufacturer with pipe straps, ensuring cables do not touch or cross.
- 3.1.3. For slab and soffit heating installations, install the cable tight to the bottom of the slab as per the manufacturer's written installation instructions using equipment supplied by the manufacturer.
- 3.1.4. Install soffit and slab heating cables at a maximum spacing of 375 mm (15 in.) between the runs of cable unless otherwise specified by the manufacturer to suit the required outside air design temperature. Spacing to be confirmed through the Shop Drawings.
- 3.1.5. Strap thermostat bulb to pipe clear of cable, and mount thermostat on wall or roof with brackets. Hang capillary on straps.
- 3.1.6. For slab and soffit heating applications, install thermostat remote bulb (temperature sensor) in between two runs of heating cable and in capped rigid galvanized steel conduit, either within the concrete slab or attached to the bottom of it. Conduit to allow sensor to be replaced easily should it fail. Also install in accordance with manufacturer's written instructions and mount thermostat in accessible location allowing for ease of access.
- 3.1.7. Retain the services of the manufacturer to inspect and approve the entire installation before the pipe or slab/soffit is concealed and/or insulated. Check for breaks with a 2500 volt DC megger. Provide report for inclusion in the operating manuals. The cost of inspection shall be included in the Contract Price. This Contractor shall provide pre-commissioning and final commissioning.
- 3.1.8. The installation by this Section shall be complete requiring power supply only by the Electrical Division. Provide all wiring between the electric tracing and the electrical junction box and make final connections.

END OF SECTION

20 05 48.00 Vibration and Noise Control

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Concrete Work on grade or cast integrally with a floor is provided under Division 3.

1.2.2. Sound isolated concrete floors – under Division 13.

1.3. SUBMITTALS

1.3.1. Shop Drawings: Supply Shop Drawings of the vibration and noise control equipment being supplied in accordance with Section 20 05 03.00 - SHOP DRAWINGS. Provide Shop Drawings showing completely the various acoustic assemblies. Include on the Shop Drawings the equipment weight at each isolator and the isolator proposed to be used complete with its weight rating. Submit Shop Drawings after all major equipment (e.g. chillers, cooling towers, etc.) has been reviewed and isolators have been coordinated.

1.4. PERFORMANCE REQUIREMENTS

1.4.1. Adequately isolate all equipment to maintain acceptable noise levels in the occupied area of the building as specified below. Take noise measurements over the complete audible frequency range in each of the occupied zones under, above and beside Mechanical Equipment Rooms, and where indicated by the Engineer's Representative. Noise levels due to mechanical equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall not exceed sound pressure levels in all 8 octave bands corresponding to the NC levels per ASHRAE handbook as indicated.

1.4.2. AREAS NC LEVELS

Residential Suites	30 NC
General offices	35 NC
Meeting Rooms	35 NC
Corridor and Lobbies	35 NC
Storage Rooms	40 NC
Entrance Halls	40 NC
Amenity Space	35 NC
Fitness	40 NC
Pool	40 NC
Outdoors	45 dBA

1.5. WARRANTY

1.5.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

- 2.1.1. All equipment provided for vibration isolation or noise control shall be new and manufactured specifically for the purpose intended.
- 2.1.2. All vibration isolation devices shall be Vibro-Acoustics, Kinetics Noise Control, VMC Amber Booth, Isotech, or Mason Industries and shall be one manufacturer throughout the Project.
- 2.1.3. All factory built silencers and acoustic plenums shall be Vibro-Acoustics, Kinetics Noise Control/Vibron, VAW Systems or EH Price and shall be one manufacturer throughout the Project.
- 2.1.4. Provide vibration isolation devices for all motorized or electrical equipment. Static deflection of isolators shall be as given in the Vibration Isolation Schedule and/or as specified below. The Vibration Isolation Schedule shall take precedence.
- 2.1.5. Provide silencers in accordance with the Silencer Schedule and/or as shown on Drawings to maintain acceptable noise levels.
- 1.1.2. Provide vibration isolation with integral seismic resisting for equipment intended to provide resisting from seismic and wind forces. Housings shall be capable of withstanding the applicable design forces for the specific installation. Installation shall be in accordance with Section 23 05 49.00 – SEISMIC FORCE RESISTING SYSTEMS.

2.2. VIBRATION ISOLATION

- 2.2.1. Type EP (Elastomeric Pad) - Vibro-Acoustics Model N, Kinetics Model NPD, Mason Industries Model W or Super W, or ISOTECH Model IR or ISOPAD.
 - .1 Type EP shall be 8 mm thick ribbed or waffle neoprene pads. Isolator pads shall be selected for less than 80 % maximum rated load.
 - .2 If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
- 2.2.2. Type MEP (Metal and Elastomeric Sandwich Pad) - Vibro-Acoustics Model NSN, Kinetics Model RSP, Mason Industries Model WSW, or ISOTECH Model IRMR or IPMP.
 - .1 Type MEP shall consist of two 8 mm thick ribbed or waffle neoprene pads bonded to each side of a 16-gauge stainless or galvanized steel shim plate. Isolator pads shall be selected for less than 80 % maximum rated load.
 - .2 If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
- 2.2.3. Type DDNM (Double Deflection Neoprene Mounts) - Vibro-Acoustics Model RDM, Kinetics Model RD, Mason Industries Model ND, or ISOTECH Model IDR.
 - .1 Type DDNM shall be laterally stable, double deflecting, molded neoprene isolators. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed and bolt holes shall be provided in the base. The mounts shall have leveling bolts rigidly secured to the equipment.
 - .2 DDNM mounts shall be selected for a static deflection of 9.5 mm unless specified otherwise.
- 2.2.4. Type DDNH (Double Deflection Neoprene Hangers) - Vibro-Acoustics Model RHD, Kinetics Model RH, Mason Industries Model HD, or ISOTECH Model IHND.

- .1 Type DDNH shall consist of a molded neoprene isolating element in a steel hanger box. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel. The diameter of the clear hole in the hanger box shall be at least 19 mm larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30 degree arc. When installed the hanger box shall be allowed to rotate through a full 360 degrees without encountering an obstruction.
- .2 Unless otherwise specified the static deflection of DDNH hangers shall be 8 mm.
- 2.2.5. Type SPNM (Spring and Neoprene Mounts) - Vibro-Acoustics Model FS, Kinetics Model FDS, Mason Industries Model SLFSW, or ISOTECH Model IOSB.
 - .1 Type SPNM shall have a free standing and laterally stable steel spring without any housing, and two type WP isolation pads sandwiching a 16 gauge stainless or galvanized steel separator plate shall be bonded to the isolator base plate. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between one and two. The spring diameter shall not be less than 80 % of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50 % of the specified static deflection.
 - .2 Unless otherwise specified the minimum static deflection of SPNM isolators under actual load conditions for equipment mounted on grade slabs shall be 25 mm (1 in.), and 50 mm (2 in.) for equipment mounted elsewhere.
 - .3 Unless otherwise specified, isolators need not be bolted to the floor for indoor installations. If base plates are bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
- 1.1.3. Type SPNMS (Spring and Neoprene Mounts - Seismic Restrained) - Vibro-Acoustics Model SFS, Kinetics Model FHS, Mason Industries Model SSLFH, or ISOTECH Model IHSS or IPSSA.
 - .4 Type SPNMS shall be laterally stable restrained steel spring type. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between one and two. The spring diameter shall not be less than 80 % of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50 % of the specified static deflection.
 - .5 Unless otherwise specified the minimum static deflection of SPNMS isolators under actual load conditions for equipment mounted on grade slabs shall be 25 mm (1 in.), and 50 mm (2 in.) for equipment mounted elsewhere.
 - .6 Isolators shall be bolted to the floor and equipment. A neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
- 2.2.6. Type SPH (Spring Hangers) - Vibro-Acoustics Model SH, Kinetics Model SH, Mason Industries Model 30, or ISOTECH Model IHS, IHA or IHB.
 - .1 Type SPH shall consist of a steel spring and welded steel housing. Spring diameter and hanger box hole shall be large enough to permit the hanger rod to swing through a 30 degree arc. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 19 mm (3/4 in.) larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked, and the hanger box shall be allowed to rotate through a full 360 degree arc without encountering any obstructions.
 - .2 Unless otherwise specified, the static deflection of SPH hangers under actual load conditions shall be 50 mm (2 in.).

- 2.2.7. Type SPNH (Spring and Neoprene Hangers) - Vibro-Acoustics Model SHR, Kinetics Model SRH, Mason Industries Model 30N, or ISOTECH Model IHSE, IHAE or IHBE.
- .1 Type SPNH shall consist of a steel spring and welded steel housing. Spring diameter and hanger box hole shall be large enough to permit the hanger rod to swing through a 30 degree arc. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 19 mm (3/4 in.) larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked, and the hanger box shall be allowed to rotate through a full 360 degree arc without encountering any obstructions.
 - .2 Type SPNH shall include the addition of a neoprene element in series with the spring. The neoprene element shall have a deflection of not less than 9 mm with a strain not exceeding 15 %. Unless otherwise specified, the static deflection of SPNH hangers under actual load conditions shall be 50 mm (2 in.).
- 2.2.8. Type CSNM (Constrained Spring and Neoprene Mounts) - Vibro-Acoustics Model CSR, Kinetics Model FLS, Mason Industries Model SLR, or ISOTECH Model ICSN.
- .1 Type CSNM shall be a spring and neoprene mount that incorporates a housing which contains unrestrained stable springs with built-in leveling device and resilient vertical limit stops to prevent spring elongation when partial load is removed and limits the movement of equipment when it is subjected to wind loading.
 - .2 A minimum clearance of 25 mm (1 in.) shall be maintained around the restraining bolts and between the housing and the spring so as not to interfere with the spring operation. Limit stops shall provide minimum 6 mm (1/4 in.) clearance under normal operation, and a neoprene washer shall be installed beneath the bolt head/washer used to restrain the isolator.
 - .3 For installations subject to wind load, provide tapped hole in top and bottom plates for bolting to equipment and the roof or supporting structure with a neoprene sleeve.
 - .4 Provide minimum 6 mm thick neoprene acoustical base pad on the underside of the mount unless designated otherwise.
 - .5 Mount shall be capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.
 - .6 Unless specified otherwise, the minimum static deflection for Type CSNM mounts under actual load conditions shall be 50 mm (2 in.).
- 1.1.4. Type SCSNM (Constrained Spring and Neoprene Mounts - Seismic Restrained) - Vibro-Acoustics Model SCSR, Kinetics Model FLSS, Mason Industries Model SLRS, or ISOTECH Model ISCSA.
- .7 Type SCSNM shall be a spring and neoprene mount that incorporates welded steel housings and heavy top plates containing laterally stable restrained springs with built-in leveling device and vertically restraining limit stops to prevent spring elongation when partial load is removed and limits the movement of equipment when it is subjected to wind or seismic loading.
 - .8 A maximum clearance of 6 mm (1/4 in.) shall be maintained around the restraining bolts and between the housing and the spring so as not to interfere with the spring operation. Top plate and restraining bolts shall be out of contact with the housing during normal operation.
 - .9 Provide tapped hole in top and bottom plates for bolting to equipment and the roof or supporting structure with a neoprene sleeve.
 - .10 Provide minimum 6 mm thick neoprene acoustical base pad on the underside of the mount unless designated otherwise.

- .11 Mount shall be capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.
- .12 Unless specified otherwise, the minimum static deflection for Type SCSNM mounts under actual load conditions shall be 50 mm (2 in.).
- 2.2.9. Type RTIC (Rooftop Isolation Curb) - Vibro-Acoustics Model RTR, Kinetics Model KSR, Mason Industries Model RSC, or ISOTECH Model IVC.
 - .1 Type RTIC shall be curb type rail with integral isolators which is designed to fit over the roof curb and under the isolated equipment. The top and bottom members shall contain weather resistant springs having a minimum 25 mm (1 in.) deflection with 50% additional travel to solid. Spring diameter shall not be less than 80% of the compressed height of the spring.
 - .2 Wind resistance shall be provided by means of resilient snubbers with a minimum clearance or 6 mm (1/4 in.) so as not to interfere with the spring action except in high winds.
 - .3 The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof, flexible neoprene connection joining the outside perimeter of the upper and lower members.
 - .4 The curb shall be manufactured as a single assembly.
- 2.2.10. Type SB (Steel Base) - Vibro-Acoustics Model S, Kinetics Model SFB, Mason Industries Type MSLSFW, or ISOTECH Model ISB.
 - .1 Type SB base which shall be a structural steel base frame with clearance holes located to correspond to the mounting bolt holes of the equipment mounted on the base. Fan bases shall have built-in motor slide rails, and shall be reinforced as necessary to withstand belt pull without drive misalignment or base distortion.
 - .2 The bases shall be constructed with deep angle steel sections with a minimum vertical angle leg of 100 mm (4 in.) for motors of 7.5 hp or less, 125 mm (5 in.) for motors between 7.5 hp and 20 hp, and 150 mm (6 in.) for motors over 20 hp.
 - .3 Structural steel base frames shall be galvanized.
- 2.2.11. Type CB (Concrete Base) - Vibro-Acoustics Model C, Kinetics Model CIB-L, Mason Industries Type KSLFSW, or ISOTECH Model ICIB
 - .1 Type CB inertia base shall have an integral rectangular structural steel form to which concrete is poured.
 - .2 Perimeter members shall be beams of depth equal to 10% of the longest span of the base, but not more than 300 mm (12 in.) or less than 150 mm (6 in.) deep. Forms shall include motor slide base and all reinforcing steel. Where anchor bolt locations fall in concrete, the reinforcing steel shall include drilled members with sleeves welded below the steel to accept the anchor bolts. Height saving steel brackets shall be used in all mounting locations.
 - .3 When the concrete base is T-shaped, isolators shall be located under the projections as well as under the main body in order to prevent cantilever distortion.
 - .4 Inertia bases for pumps shall be of sufficient size to accommodate supports for pipe elbows at pump suction and discharge connections.
 - .5 Height saving brackets or welded steel pockets shall be incorporated in ensure a 50 mm (2 in.) minimum clearance under each inertia base.
 - .6 The weight of each inertia base shall be sufficient to lower the centre of gravity to or below the isolator support plane.
 - .7 The structural perimeter frame, mounting templates, height saving brackets, and spring system shall be provided as an assembly by the vibration control vendor.

- .8 Structural perimeter frames shall be galvanized.
- 2.2.12. All spring mounts shall be complete with levelling devices 6 mm (1/4 in.) thick ribbed neoprene sound pads and completely colour coded stable springs.
- 2.2.13. Where steel spring isolation systems are described in the Specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 80 % of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the spring remain parallel during and after spring installation.
- 2.2.14. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50 % above the design deflection.
- 2.2.15. All vibration isolators shall have either known undeflected heights of calibration markings to that, after adjustment, verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to design.
- 2.2.16. All mounts installed outdoors or exposed to high humidity conditions shall have two coats of rust resisting paint and springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated. All metal parts of mountings (except springs and hardware) shall be hot dip galvanized.
- 2.2.17. Flexible spherical expansion joints shall be constructed of EPDM in the covers, liners and with Kevlar tire cord frictioning.
 - .1 Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not permitted.
 - .2 19 mm (3/4 in.) to 38 mm (1-1/2 in.) shall have threaded two piece bolted flange assemblies, one sphere and cable retention.
 - .3 50 mm (2 in.) and larger shall have two spheres reinforced with a ductile iron external ring between spheres.
 - .4 400 mm (16 in.) to 600 mm (24 in.) shall be single sphere.
 - .5 Flanges shall be split ductile iron or steel with hooked or similar interlocks.
 - .6 Connectors shall be rated at 1.72 MPa (250 psi) up to 77 Deg. C. (170 Deg. F.) with a uniform drop in allowable pressure to 1.48 MPa (215 psi) at 121 Deg. C. (250 Deg. F.) in sizes through 350 mm (14 in.). 400 mm (16 in.) through 600 mm (24 in.) single sphere minimum ratings shall be 1.24 MPa (180 psi) at 77 Deg. C. (170 Deg. F.) and 1.03 MPa (150 psi) at 121 Deg. C. (250 Deg. F.).
 - .7 Higher rated connectors shall be used to accommodate service conditions where required.
 - .8 Factory test all expansion joints to 150 % of the rated pressure. Safety factors to burst and flange pullout shall be a minimum of 3/1.
- 2.2.18. Neoprene mounting sleeves for hold down applications of equipment with vibration isolators shall be Uniroyal Type 620/660 or as approved.
- 2.2.19. Grout: Non-shrink, self-levelling grout having ability to withstand thermal, vibratory and impact stresses.
- 2.2.20. Acoustic Sealant: Non-hardening, non-skinning permanently flexible, to CAN/CGSB-19.21 "Sealing and Bedding Compound, Acoustical." Tremco, CGC Acoustic Sealant or approved equivalent.
- 2.3. INTERNAL ACOUSTIC DUCT LINING
 - 2.3.1. Fiberglass duct lining manufacturer: Certainteed, Owens-Corning, Knauf Insulation, or Johns Manville.

- 2.3.2. Natural fibre duct lining manufacturer: Bonded Logic.
- 2.3.3. Provide acoustic duct lining with a minimum density of 24 kg/m³ (1.5 lbs/ft³).
- 2.3.4. Provide acoustic duct lining that complies with the requirements of NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilation Systems" and the "Duct Liner Materials Standard" of the Thermal Insulation Manufacturer's Association.
- 2.3.5. Provide internal acoustic duct lining that incorporates means to prevent fiber entrainment in the air stream, such as airstream surface and long edges complete with acrylic polymer surface coating.
- 2.4. ACOUSTICAL DUCT AND PIPE LAGGING
 - 2.4.1. Acoustical duct and pipe lagging shall be Kinetics Model KNM-100ALQ.
 - 2.4.2. The barrier shall be constructed of a 2 mm (1/16 in.) thick barium sulphate loaded limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side. The barrier shall have a nominal density of 4.8 kg/m² (1 lbs/ft²) and shall have a minimum STC rating of 28.
 - 2.4.3. The barrier shall have a minimum thermal conductivity "K" value of 0.29 and a rated service temperature range of -40 Deg. C. (-40 Deg. F.) to 105 Deg. C. (220 Deg. F.).
 - 2.4.4. The barrier shall have a Flame Spread Index of no more than 25 and a Smoke Development Index of no more than 50 when tested for Surface Burning Characteristics per ASTM E84 "Standard Test Method for Surface Burning Characteristics of Building Materials."
 - 2.4.5. The decoupling layer shall be a combination of 25 mm (1 in.) or 50 mm (2 in.) as shown, fibreglass batting, non woven porous scrim-coated glass cloth, quilted together in a matrix of diamond stitch pattern which encapsulates the glass fibres. The composite material shall be fabricated to include a nominal 152 mm (6 in.) wide barrier overlap tab extending beyond the quilted fibreglass to facilitate a leak-tight seal around field joints.
- 2.5. SILENCERS
 - 2.5.1. Provide factory-built silencers completely pre-fabricated of incombustible materials and bearing a minimum insertion loss and a maximum air pressure drop as shown in Silencer Schedule. Include all system effects in the installed position shown on the Drawings in the silencer performance. Conform to ASTM E477 "Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers" for submitted silencer performance.
 - 2.5.2. Media filled silencers shall contain acoustic media type as indicated on the Silencer Schedule, either acoustic quality, shot free glass fibre insulation with long, resilient fibres bonded with a thermosetting resin, or 100% natural cotton fibres treated with an EPA registered, non-toxic borate solution, "flash dried" to provide resistance to mould, mildew and fungi. Media shall not cause or accelerate corrosion of aluminum or steel. Glass fibre, and rockwool will not be permitted as a substitute for cotton fibre media.
 - 2.5.3. Acoustic media in media filled silencers shall have density as required to provide specified performance, packed under 15 percent compression and protected from air erosion by perforated sheet metal, gauge as specified below.
 - 2.5.4. Acoustic media filled silencers with internal air velocities above 22.9 m/s (4500 fpm) shall have acoustic media wrapped with glass fibre cloth for additional erosion protection.
 - 2.5.5. Silencers shall have acoustic media wrapped in Tedlar film liner to help prevent shedding, erosion and impregnation of the acoustic media in the following areas:
 - .1 Where indicated on Silencer Schedules

- 2.5.6. No-media silencers shall contain no absorptive media of any kind. Attenuation shall be achieved with controlled impedance membranes and broadly tuned resonators.
- 2.5.7. Silencer materials, including acoustic media and Tedlar film, shall have the following combustion ratings when tested in accordance with ASTM E84 "Standard Test Method for Surface Burning Characteristics of Building Materials": maximum Flame spread Classification 25, maximum Smoke Development Rating 50.
- 2.5.8. Rectangular type silencers for duct systems operating less than 4 in. WG and designated as Class 1 on the Silencer Schedule shall be constructed with a minimum 22 gauge (0.78 mm) lock formed galvanized steel outer casing and 26 gauge (0.47 mm) galvanized perforated steel liner.
- 2.5.9. Rectangular type silencers for duct systems operating greater than 4 in. WG and less than 8 in. WG and/or designated as Class 2 on the Silencer Schedule shall be constructed with a minimum 18 gauge (1.18 mm) Pittsburgh lock formed galvanized steel outer casing and 22 gauge (0.78 mm) galvanized perforated steel liner.
- 2.5.10. Rectangular type silencers for duct systems operating under more than 8 in. WG and/or designated as Class 3 on the Silencer Schedule shall be constructed with a minimum 16 gauge (1.46 mm) continuously welded galvanized or hot rolled steel painted with one anti-rust prime coat of paint casing and 22 gauge (0.78 mm) galvanized perforated steel liner.
- 2.5.11. Rectangular type elbow silencers shall have minimum Class 2 construction, 18 gauge (1.18 mm) Pittsburgh lock formed galvanized steel outer casing and 22 gauge (0.78 mm) galvanized perforated steel liner, unless indicated as Class 3 on the Silencer Schedule. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 1200 mm (48 in.) shall have at least two half splitters and one full splitter.
- 2.5.12. Circular media filled silencers, unless noted on the Silencer Schedule as Class 3, 16 gauge (1.46 mm) construction shall have gauges and construction as follows: under 750 mm (30 in.) casing diameter, 20 gauge (0.91mm) lockformed galvanized steel outer casing, under 1350 mm (54 in.) casing diameter, 18 gauge (1.18 mm) lockformed galvanized steel outer casing, otherwise 16 gauge (1.46 mm) stitch welded galvanized steel outer casing. Galvanized steel perforated inner liner shall be 22 gauge (0.78 mm) for all diameters.
- 2.5.13. Circular no-media silencers, unless noted on the Silencer Schedule as Class 3, 16 gauge (1.46 mm) construction shall have gauges and construction as follows: under 450 mm (18 in.) duct diameter, 22 gauge (0.78 mm) lockformed galvanized steel outer casing, under 750 mm (30 in.) duct diameter, 20 gauge (0.91 mm) lockformed galvanized steel outer casing, under 1350 mm (54 in.) duct diameter, 18 gauge (1.18 mm) lockformed galvanized steel casing, otherwise 16 gauge (1.46 mm) stitch welded galvanized steel outer casing. Galvanized steel perforated inner liner shall be 26 gauge (0.47 mm) for all diameters.
- 2.5.14. Silencers shall be complete with high transmission loss (HTL) casing where indicated on the silencer schedule. HTL walls shall consist of media, airspace, mass and outer protective metal skin as required to obtain specified room noise criteria. Standard acoustic panels will not be accepted as HTL walls. Where requested by the Engineer's Representative, provide breakout noise calculations for each air handling and fan system with silencer submittal to ensure compliance with the room noise criteria. Breakout noise calculations shall be based on the sound power levels of the specified equipment and calculation methods in accordance with ASHRAE HVAC Applications handbook.

3. Execution

3.1. INSTALLATION

- 3.1.1. Obtain one copy of all Shop Drawings of equipment to be isolated showing weights, shaft centres and all dimensions.
- 3.1.2. On system start-up, inspect the complete installation and provide a report in writing.
- 3.1.3. Furnish concrete bases, including concrete fill, on springs or other vibration isolation materials for mechanical isolation.
- 3.1.4. All floor mounted equipment shall be erected on concrete housekeeping pads, with thickness as identified, over the complete floor area of the equipment, unless shown or specified otherwise. Wherever vibration eliminating devices and/or concrete inertia pads are specified, these items shall be mounted on concrete housekeeping pads.
- 3.1.5. Furnish and install neoprene mounting sleeves for hold-down bolts to prevent any metal to metal contact.
- 3.1.6. All equipment shall be provided with lateral restraining isolators as required to limit horizontal motion to 6 mm maximum, under all operating conditions. Lateral restraining isolators shall have the same static deflection as equipment being isolated.
- 1.1.5. Seismic snubbers shall be installed on all equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 3.2 mm (1/8 in.). Install seismic restraint devices using methods approved by required submittals for component.
- 3.1.7. Unless otherwise indicated, all equipment mounted on vibration isolators shall have a minimum operating clearance of 50 mm (2 in.) between the bottom of the equipment or inertia base (and height-saving bracket) and the concrete housekeeping pad (or bolt heads) beneath the equipment. The clearance shall be checked by the Contractor to ensure that no material has been left to short-circuit the vibration isolators. There shall be a minimum 100 mm (4 in.) clearance between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.
- 3.1.8. Piping, ductwork, conduit or mechanical equipment shall be supported from building structure, not hung from or supported on other equipment, pipes, or ductwork.
- 3.1.9. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping, and blocked-up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims.
- 3.1.10. All mechanical equipment not specifically identified in this Section that contains rotating or vibrating elements, and any associated electrical apparatus installed by this Division that contains transformers or inductors shall be installed on Type DDNM, MEP, or EP isolators as appropriate.
- 3.1.11. All wiring connections to mechanical equipment on isolators shall be made with a flexible conduit installed in a slack "U" shape.
- 3.1.12. Elastomeric isolators that will be exposed to temperatures below 0 deg. C. (32 deg. F.) shall be fabricated from natural rubber instead of neoprene.
- 3.1.13. Springs shall be designed and installed so that ends of springs remain parallel and all springs installed with adjustment bolts.
- 3.1.14. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.

- 3.1.15. Fans and air handling units shall be levelled with fans operating before the flexible connectors are attached.
- 3.1.16. All fan bases and isolators shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.
- 3.2. EQUIPMENT ISOLATION
- 3.2.1. Floor Mounted Centrifugal Fans and axial flow fans less than 0.87 kPa (3-1/2 in. WG) static pressure and/or under 29.8 kW (40 hp), shall be mounted on a Type SB base with Type SPNM isolators and shall have static deflection not less than 50 mm under actual load conditions unless shown otherwise in the Vibration Isolation Schedule.
- 3.2.2. Floor Mounted Centrifugal Fans and axial fans 0.87 kPa (3-1/2 in. WG) static pressure and over and/or 29.8 kW (40 hp) and larger, shall be mounted on Type CB with Type SPNM isolators and shall have static deflection not less than 50 mm (2 in.) under actual load conditions unless stated otherwise on the Vibration Isolation Schedule.
- 3.2.3. Ceiling Suspended Centrifugal Fans, and axial flow fans shall be mounted on Type SPNH spring isolators. Static deflection of the isolators shall be 50 mm (2 in.) unless shown otherwise on the Vibration and Isolation Schedule. Fans shall be suspended from above only if expressly noted as such on the Drawings and Schedules. Thrust restraint shall be by pre-compressed springs.
- .1 If the fan to be suspended is not furnished with integral structural frame and external mounting lugs of suitable strength and rigidity, install approved structural base with lugs in the field.
- 3.2.4. Fans in packaged or custom air handling units shall be mounted on a Type SB base with Type SPNM isolators. The static deflection shall not be less than 50 mm (2 in.) under actual load conditions.
- .1 Structural steel floor supports shall be located beneath the spring isolators and shall be equivalent to the structural perimeter frame of the air handling unit.
- .1 Custom or packaged air handling units with spring isolation shall be mounted on 25 mm (1 in.) Type MEP isolators between the unit base rail and the housekeeping pad or curb.
- 3.2.5. Roof mounted air conditioning units without internal fan isolation shall be mounted on RTIC isolator. Static deflection shall be as shown in the Schedules.
- .1 For roof mounted units that have openings through the structure directly below the unit provide a flexible neoprene coated canvas connection to provide an air tight/weather tight finish between the unit and the curb.
- 3.2.6. Floor mounted air handling units
- .1 Install Type MEP isolation under floor mounted air handling units located above occupied areas. Where hold down fasteners are used, include neoprene vibration isolation washers and sleeves.
- 3.2.7. Base mounted pumps 3.73 kW (5 hp) and larger except where located on slab-on-grade. Mount each pump with motor on a Type CB inertia base. Minimum base thickness shall be:
- .1 Pumps 3.73 kW (5 hp) to 5.52 kW (7.5 hp) 150 mm (6 in.)
- .2 Pumps 5.6 kW (7-1/2 hp) to 18.7 kW (25 hp) 200 mm (8 in.)
- .3 Pumps 22.4 kW (30 hp) to 74.6 kW (100 hp) 250 mm (10 in.)
- .4 Pumps 93.3 kW (125 hp) and larger 300 mm (12 in.)
- .1 Base for horizontally split pumps shall include supports for base elbows for the discharge and suction connections. Vertically split pumps shall include support

- for base elbow for suction connection. Bolt and grout base elbows to the pump base.
- .5 Mount the base on Type SPNM isolators. Where the base is 'T' shaped or other than rectangular, locate the isolators under the projections as well as the main body of the base.
 - .6 Pour bases on roofing felt and elevate a minimum of 50 mm (2 in.) with mounting adjustment bolts after the pumps are grouted to the base.
 - .7 No damping or snubbing materials shall be used. Spring deflection shall be as specified in the Vibration Isolation Schedule, but in no case less than 25 mm (1 in.) and all mountings shall have 6 mm (1/4 in.) thick neoprene vibration isolation pads at the bottom.
- 3.2.8. Base mounted pumps less than 3.73 kW (5 hp), except where located on slab-on-grade, bolt and grout each pump to a Type CB inertia base.
- .1 Mount the base on Type EP isolators.
 - .2 Minimum base thickness shall be 150 mm (6 in.).
- 3.2.9. Base mounted pumps On Slab On Grade: Bolt and grout each pump to a Type CB base. The minimum base thickness shall be:
- .1 Pumps up to 3.73 kW (5 hp) 150 mm (6 in.)
 - .2 Pumps 5.6 kW (7-1/2 hp) to 18.7 kW (25 hp) 200 mm (8 in.)
 - .3 Pumps 22.4 kW (30 hp) to 74.6 kW (100 hp) 250 mm (10 in.)
 - .4 Pumps 93.3 kW (125 hp) and larger 300 mm (12 in.)
 - .5 Mount the base on Type MEP isolators. Where the base is 'T' shaped or other than rectangular, locate the isolators under the projections as well as the main body of the base. The isolators shall be in accordance with the manufacturer's written instructions for the size and weight distribution of the pump supported.
- 3.2.10. Vertical in-line pumps floor mounted 7.5 kW (10 hp) and larger except where located on slab-on-grade bolt and grout each elbow support to a Type CB inertia base. The minimum base thickness shall be:
- .1 Pumps 5.6 kW (7-1/2 hp) to 18.7 kW (25 hp) 200 mm (8 in.)
 - .2 Pumps 22.4 kW (30 hp) to 74.6 kW (100 hp) 250 mm (10 in.)
 - .3 Pumps 93.3 kW (125 hp) and larger 300 mm (12 in.)
 - .4 Mount the base on Type SPNM isolators.
 - .5 Pour bases on roofing felt and elevate a minimum of 50 mm (2 in.) with mounting adjustment bolts after the pump elbows are grouted to the base.
 - .6 No damping or snubbing materials shall be used. Spring deflection shall be as specified in the Vibration Isolation Schedule, but in no case less than 25 mm (1 in.) and all mountings shall have 6 mm (1/4 in.) thick neoprene vibration isolation pads at the bottom.
- 3.2.11. Vertical in-line pumps floor mounted 5.6 kW (7-1/2 hp) and smaller and 7.5 kW (10 hp) and larger where located on slab-on-grade, shall be supported on Type MEP isolation. Refer to Mechanical Standard Details.
- 3.2.12. Vertical in-line pumps ceiling hung shall be supported by Type SPNH spring isolators. Refer to Mechanical Standard Details.
- 3.2.13. Floor mounted air compressors shall be bolted and grouted to Type CB inertia base supported by Type SPNM isolators. Spring deflection shall be 50 mm (2 in.) minimum. Resilient pipe hangers shall be as specified for piping in Mechanical Rooms.

- 3.2.14. Fan coil units or heat pumps suspended from overhead structure shall be hung on Type SPNH spring isolators. Unless otherwise specified in the Vibration and Isolation Schedule, the static deflection of the isolators shall be 50 mm (2 in.).
- 3.2.15. Refrigeration machines and boilers shall be mounted on a Type SB base with CSNM isolators. Spring deflection shall be 50 mm (2 in.) minimum. If the equipment is suitable and an additional steel base is not required, the equipment can be mounted directly on the isolators.
- 3.2.16. Diesel generator exhaust pipe shall have Type SPNH hangers for the entire length. Hangers shall have a minimum of 38 mm (1-1/2 in.) deflection.
- 3.2.17. Mount cooling tower and air source heat pumps on a Type SB base supported by CSNM isolators. Spring deflection shall be 50 mm (2 in.) minimum. If the equipment is suitable and an additional steel base is not required, the equipment can be mounted directly on the isolators.
- 3.2.18. Suspend all piping in Mechanical Rooms on Type SPH or SPNH isolators as required. Where piping is supported from the floor, weld brackets to the piping and support on Type SPNM isolators. Isolators do not replace constant support hangers or mounts.
- 3.2.19. The first isolator both upstream and downstream of equipment on springs shall have a static deflection of 1.5 times the deflection of the vibration isolated equipment to a maximum of 50 mm (2 in.). All other piping supports shall have a static deflection of 25 mm (1 in.) minimum.
- 3.2.20. Where a pipe connects to multiple pieces of equipment in the Mechanical Room the pipe isolators for the entire run shall be chosen to suit the connected equipment of the greatest static deflection.
- 3.2.21. Piping that is connected only to equipment installed on neoprene isolators shall be either supported from the floor by Type DDNM isolators or suspended from the structure on Type DDNH isolators within the Mechanical Equipment Rooms.
- 3.2.22. Install double sphere EPDM type flexible piping connectors with: control rods with grommets to limit vibration transfer; stabilizing ring; and floating flanges, to connect piping of diameter 50 mm (2 in.) or greater to reciprocating or rotating equipment.
- 3.2.23. Piping attached to either coil sections separated from the fan sections of air handling units by flexible connections, or to air handling units with internal isolators meeting the requirements of these Specifications is exempt from these requirements and is not considered connected to vibrating equipment.
- 3.2.24. No rigid connections between equipment and the building structure shall be made that degrades the specified noise and vibration control system.
- 3.2.25. Any conflicts with other trades which result in rigid contact with the equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the Engineer's Representative's attention prior to installation. If not brought to the attention of the Engineer's Representative prior to installation corrective Work necessitated by conflicts shall be at the Contractor's expense.
- 3.2.26. Locate isolation hangers with the housing a minimum of 50 mm (2 in.) below but as close as possible to the structure. Where isolator hangers would be concealed by a non-accessible acoustical sub-ceiling, install the hangers immediately below the sub-ceiling for access.
- 3.2.27. Ducts shall be connected to fans, fan casings and fan plenums by means of flexible connectors. Flexible connectors shall be installed to prevent metal-to-metal contact across flexible connection.
 - .1 Flexible connections are not permitted on NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations" kitchen exhaust systems.
 - .2 Flexible connectors shall be in accordance with Section 23 31 13.00 - DUCTWORK AND SPECIALTIES.

3.3. SILENCERS

- 3.3.1. Where silencers are to be installed in stainless steel or aluminum ductwork, the silencer shall be all stainless steel or aluminum construction to match the ductwork.
- 3.3.2. Silencers for all variable air volume boxes, and fan powered variable volume boxes shall be as scheduled in the Silencer Schedule. Refer to Drawings for specific number required. The Silencer Schedule only indicates type. Receive from VAV box manufacturer dimension and sound data. Adjust silencers as required to match box discharge size. Adjust silencer as required to ensure insertion loss necessary to meet the room noise criteria.
- 3.3.3. Silencers shall have outside dimensions that match the connecting duct size unless indicated otherwise.
- 3.3.4. Submittals shall include certified test data on dynamic insertion loss, self-noise power levels, and pressure drop for reverse or forward flow. Silencer performance must have been substantiated by laboratory testing according to ASTM E477 "Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers" and so certified when submitted for approval. The laboratory must be NVLAP accredited for the ASTM E477 test standard. Provide a copy of the accreditation certificate with the submittals upon request by the Engineer's Representative. Data from non-NVLAP accredited test facilities will not be accepted.
- 3.3.5. The certification of the pressure drop, insertion loss and generated noise data shall be based upon tests of the same silencer for all measurements.
- 3.3.6. For specific silencers indicated on the Silencer Schedule, the manufacturer shall provide acoustic analysis for approval showing that this silencer will reduce mechanical fan noise to acceptable levels in the occupied space. Use sound power levels of actual equipment to be installed on Project. Analysis shall include breakout noise calculations.

3.4. ACOUSTICAL LINING OF DUCTS

- 3.4.1. Acoustically line ductwork where shown on the Drawings and as Specified.
- 3.4.2. Provide a minimum of 25 mm (1 in.) thick acoustical duct lining in all internally lined sheet metal ducts, unless otherwise specified or shown on the Drawings.
- 3.4.3. In addition, internally line all low or medium pressure supply air ductwork in mechanical rooms, fan rooms, or equipment rooms.
- 3.4.4. Install acoustic lining using both pins and a minimum of 50 % coverage of a fire-resistant adhesive. Install pins on maximum 450 mm (18 in.) centres on all sides and tack weld to the duct or plenum. Mechanical fasteners that pierce the duct are unacceptable. Seal all edges of acoustic lining to prevent air erosion with sheet metal nosing that overlaps the insulation by 19 mm (3/4 in.) minimum. Coat all ends of the liner with a fire resistant cementing material to prevent delamination, leakage or erosion. Firmly butt all joints and coat ends with an adhesive to ensure that the lining is smooth across all joints.
- 3.4.5. For acoustic lining downstream of VAV boxes refer to Section 23 36 16.00 - VARIABLE VOLUME BOXES.
- 3.4.6. Where acoustical duct lining is installed, increase the dimensions of the sheet metal to include the thickness of the lining material. Dimensions shown on the Mechanical Drawings are the clear internal dimensions after the liner has been installed.
- 3.4.7. Internally insulate the following ductwork:
 - .1 All return air transfer ductwork.
 - .2 All ductwork specifically identified in Specifications and/or on the Drawings.

- .3 All supply and return air ductwork in the amenity spaces, lobbies, and common areas that serve that space.

3.5. ACOUSTICAL DUCT AND PIPE LAGGING

- 3.5.1. Install Acoustical Duct and Pipe Lagging where indicated on Drawings.

END OF SECTION

20 05 53.00 Pipe and Ductwork Identification

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. RELATED WORK SPECIFIED ELSEWHERE
 - 1.2.1. Field painting of non-colour coded piping and ductwork - under Division 9, Section 09 90 00.00 - PAINTING AND COATING.
 - 1.3. SUBMITTALS
 - 1.3.1. Submit designations and abbreviations for review in accordance with Section 20 05 03.00 – SHOP DRAWINGS. Submit digital samples of identification for review.
 - 1.4. WARRANTY
 - 1.4.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Paint shall be compatible with the surface material to be painted.
 - 2.1.2. Colour code shall conform to CAN/CGSB 24.3-92 “Identification of Piping Systems” and ANSI/ASME A13.1 “Scheme For The Identification Of Piping Systems.”
 - 2.1.3. Pipe covering shall be SMS, Brady, Primark Manufacturing Inc. and Seton equal to SMS Coil-Mark system pipe markers.
 - 2.1.4. All identification shall incorporate direction of flow arrows, and the specified system designations and abbreviations. Designations and abbreviations shall be submitted for review prior to installation.
 - 2.1.5. All reclaimed rainwater distribution systems shall be purple in colour and conform to requirements of NSF-RW and NSF/ANSI Standard 14 “Plastics Piping System Components and Related Materials.” All other non-potable water piping shall conform to the requirements of CAN/CSA B128.1 “Design and Installation of Non-potable Water Systems,” CAN/CSA B128.2 “Maintenance and Field Testing of Non-potable Water Systems,” and CAN/CSA B128.3 “Performance of Non-Potable Water Treatment Systems.”
 - 2.1.6. Colour code shall conform to the requirements under the by-laws of the Authority Having Jurisdiction.

3. Execution

3.1. INSTALLATION

- 3.1.1. After completion of insulation and/or painting, all piping and ductwork shall be marked to show the service and direction of flow.
- 3.1.2. Marking shall be placed at each side of any wall, partition or floor, at 9.1 m (30 ft.) intervals (maximum) on all exposed piping and ductwork and at each access panel or door. Marking shall be located so as to be in full view and visible from the floor.
- 3.1.3. All pipe identification shall be installed in accordance with the manufacturer's recommendations.
- 3.1.4. For insulated or non-insulated pipe sizes less than 150 mm (6 in.) outer diameter, provide pre-coiled pipe identification markers, cover the pipe in its entirety, and join using adhesive along the longitudinal joint. In addition to the adhesive, provide banded marking system with clear plastic tie-wraps on each end.
- 3.1.5. For insulated or non-insulated pipe sizes equal to and greater than 150 mm (6 in.) outer diameter, strap markers on with recommended tie-wraps.
- 3.1.6. Adhesive labels are not acceptable.
- 3.1.7. Gas piping shall be painted yellow for the entire length and identified with pipe identification markers. Banding is not permitted.
- 3.1.8. All electric traced piping shall have additional identification to show it is traced.
- 3.1.9. Identify ductwork with 50 mm (2 in.) stencils using black or white ink to contrast the surface being identified.
- 3.1.10. Identification location for ductwork shall conform to the guidelines for pipe and shall indicate flow medium, function, and direction.
- 3.1.11. Contractor shall ensure stenciling is performed in a neat, quality manner.

END OF SECTION

20 05 54.00 Nameplates

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Nameplates for systems include the designated equipment name, model number and main design parameters.

1.1.3. Every piece of equipment shall have a nameplate.

1.2. SUBMITTALS

1.2.1. Submit samples of nameplates before installation in accordance with Section 20 05 03.00 – SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. The nameplates must be a minimum 2 mm (3/32 in.) thick micro surface impact acrylic suitable for a service temperature up to -29 Deg. C. through 80 Deg. C. (-20 Deg. F. through 175 Deg. F.). Minimum size shall be 100 mm (4 in.) long x 50 mm (2 in.) wide with maximum size to suit nomenclature required. Nameplate shall be with black face and white centre and with 5 mm (7/32 in.) high lettering engraved through to the white lamination.

2.1.2. The nameplates shall have the equipment type and name as indicated in the Equipment Schedules.

2.1.3. The nameplates shall have the service and area of the building served (e.g. Chilled Water - South Zone).

3. Execution

3.1. INSTALLATION

3.1.1. Nameplates shall be securely fastened with screws or brass chains in a conspicuous place on the equipment.

END OF SECTION

20 05 55.00 Valve Tags and Charts

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. SUBMITTALS
 - 1.2.1. Submit samples of charts and numbering system before installation in accordance with Section 20 05 03.00 – SHOP DRAWINGS.
 - 1.3. WARRANTY
 - 1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Tags must be a minimum 2 mm (3/32 in.) thick Micro Surface Impact Acrylic suitable for a service temperature up of -29°C through 80°C (-20°F through 175°F), with engraved numbers and/or letters as required. Tags shall be a minimum of 25 mm (1 in.) square and maximum to suit numbering system. Numbers shall be nominally 9 mm (3/8 in.) high. Letters shall be nominally 6 mm (1/4 in.) high.
 - 2.1.2. Number and nameplates for standpipe and sprinkler system supervisory and main operating valves shall be minimum 2 mm (3/32 in.) thick laminated phenolic plastic and a minimum 125 mm (5 in.) long x 100 mm (4 in.) wide with red face and white centre. Lettering shall be a minimum 9 mm (3/8 in.) high with maximum to suit local authorities and shall be engraved through to the white lamination. Each nameplate shall contain the system name, service and valve number.
 - 2.1.3. For all other valves on standpipe and sprinkler system not required to have laminated number and nameplates, provide plastic tags as specified above.
 - 2.1.4. Abbreviations and colour code shall be as shown on Standard Details.
3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Tags and nameplates shall be attached to the valve body or handle with brass hooks or chains.
 - 3.1.2. All valves shall be provided with tags, other than valves on convectors, induction units or other space heating, cooling units and valves on plumbing fixtures. Provide a chart or charts, indicating location, service and zone of each valve. This Work shall be co-ordinated between the various Mechanical Sections to prevent overlapping of numbering systems.
 - 3.1.3. Provide separate charts for all fire system nameplates and tags.

- 3.1.4. For extension and/or alterations to existing systems, provide new charts conforming in appearance to the existing charts.
- 3.1.5. Co-ordinate valve identification with pipe and ductwork identification.
- 3.1.6. Roof drains used for restricting or controlling the flow of water from the roof or acting as an overflow shall be affixed with an identification label "Control Flow Roof Drain - Do Not Remove Restriction Device".
- 3.1.7. Electronically submit charts as PDF files along with as-built drawings. Provide charts set in metal picture frames with a clear acrylic front and fastened securely where directed by Engineer's Representative.
- 3.1.8. All valve tag numbers for all systems shall be shown on the as-built drawings.

END OF SECTION

20 05 63.00 Access Doors and Accessibility

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings showing size, type and location of all access doors, for review, before installation in accordance with Section 20 05 03.00 – SHOP DRAWINGS.

1.2.2. Have Balancing Contractor review proposed access door sizes and locations to ensure that sufficient access is available. Confirm in writing that this review has occurred.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Provide access doors that comply with Section 08 31 00 - ACCESS DOORS AND PANELS from the Architectural Specification. Where the Architectural Specification section is silent on a required access door type, comply with the Part 2 clauses in this section.

2.1.2. Provide access doors by Acudor, Bauco or Mifab Manufacturing Inc. Steel thickness (US Gauge) indicated as minimum acceptable.

2.1.3. For doors in solid walls, provide a 16 US gauge, prime painted steel door panel, rust resistant concealed hinges, flanged frame, and screwdriver operated lock. Acudor Model UF-5000 or Mifab Model UA.

2.1.4. For doors in drywall partitions or ceilings, provide a minimum 22 US gauge, prime painted steel recessed door panel for the acceptance of a drywall insert, concealed hinges, drywall bead frame, and screwdriver operated lock. Bauco Plus II, Acudor model DW-5015 or Mifab Model CAD-DW.

2.1.5. For doors in drywall partitions or ceilings, provide prime painted steel flush door panel, concealed hinges, drywall bead frame, and screwdriver operated lock. Acudor model DW-5040 or Mifab Model MDW.

2.1.6. For access doors in fire rated walls or ceilings, provide ULC labeled with insulated door panel, concealed hinge, self-closing, self-latching, flanged frame, and prime painted. Provide master key operated catch in areas accessible to the public. Acudor Model FW-5050 or Mifab MPFR.

2.1.7. For doors in tiled walls or ceilings, provide 16 US gauge, stainless steel, type 304 with #4 satin finish, concealed hinges, wall frame and screw driver operated lock. Acudor Model UF-5000 or Mifab Model UA-SS.

2.1.8. For doors in tiled walls or ceilings, provide 16 US gauge, prime painted steel recessed door panel for the acceptance of tile finish, concealed hinges, flush frame and screw driver operated lock. Acudor Model AT-5020 or Mifab Model CAD.

- 2.1.9. For doors for medium and high security applications in solid walls, provide 10 US gauge door with minimum 4 mm (3/16 in.) welded angle frame with heavy duty butt hinges welded to the door and frame with master keyed cylinder lock provided by the Owner. Acudor Model SD-6000 or Mifab Model MI-SADH.

3. Execution

3.1. INSTALLATION

- 3.1.1. Provide access doors of minimum 600 mm x 600 mm (24 in. x 24 in.) size. Custom size access doors may be required to allow combining access doors in close proximity and to ensure maintenance and accessibility of all parts requiring periodic maintenance.
- 3.1.2. Ensure all parts of the installation requiring periodic maintenance are accessible. Wherever valves, dampers and other appurtenances are concealed by building construction, provide access doors and install under the respective Trade Sections (i.e. masonry, plaster, drywall, tile, etc.). Be responsible for the proper location of the access doors.
- 3.1.3. For all mechanical equipment located above drywall and other inaccessible ceilings, provide access doors that will allow for full removal and replacement.
- 3.1.4. For wall mounted plumbing fixtures with back water connection, provide an adjacent access door.
- 3.1.5. Where access doors are required in ductwork requiring a fire rating, install them in accordance with the fire rating system manufacturer's written installation instructions, to ensure that the Product listing is not compromised.
- 3.1.6. Wherever possible, locate items requiring access in easily accessible areas (i.e. exposed or T-bar ceilings).
- 3.1.7. Group items in order to minimize the number of access doors required.
- 3.1.8. Install each access door to provide complete access to equipment for maintenance and servicing.
- 3.1.9. Make any changes to locations of access doors as directed by the Engineer's Representative.
- 3.1.10. Show the final installed locations of all access doors on the as-built drawings.

END OF SECTION

20 05 73.00 Excavation and Backfill for Mechanical Work

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. This Section governs requirements for all Work required for the installation of underground storm drains, sanitary sewers, gas lines, pressurized water lines, and appurtenances associated with such services.

- .1 Excavation and backfill Work includes all Work within the building footprint (plan), and extends to a point 1500 mm (5 ft. 0 in.) beyond face of building foundation line. Services underground within interior courtyards are included in this Section.

1.1.3. Assume that material to be excavated is earth. When rock is encountered during construction, payment will be made on unit price basis to the extent of net difference in cost between dry earth excavation and solid rock excavation, all as indicated in Contract Documents.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Removing subgrade materials for service trenches inside and outside building perimeter, for general grade adjustments, and backfilling of trenches from top of bedding up to bottom of slab-on-grade - under separate Contract.

1.2.2. Dewatering of Site - under Division 31.

1.2.3. Rock excavating and spreading - under Division 31.

1.2.4. Finish grading and spreading of topsoil - under Division 31.

1.2.5. Weeping tile drainage lines and filter media - under Division 31.

1.3. SUBMITTALS

1.3.1. Provide Shop Drawings indicating proposed method of bedding and backfilling in accordance with Section 20 05 03.00 – SHOP DRAWINGS.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. SOILS

2.1.1. Provide Granulars “A”, “B” (Type 1), “M” and “Select Subgrade Material”;

- .1 CAN/CSA A23.1 “Concrete materials and methods of concrete construction” and CAN/CSA A23.2 “Test methods and standard practices for concrete.”
- .2 Ontario Provincial Standard Specifications (OPSS), Form No. 1010

- 2.1.2. Requirements for Pea Gravel: Granular, well-graded clean rounded pea gravel or stone with not more the 2% material that will pass 75 um (No. 200) sieve, maximum 6 mm (¼ in.), containing not other deleterious material, and subject to testing that specified density can be achieved without compaction.
- 2.1.3. Requirements for Sand Fill: Uniform quality and unwashed river sand or any clean sand containing less than 5% organic materials, clay or silt (passing 125 um sieve) is acceptable. It can contain a limited amount of small stones or rocks as it comes from the pit. Sharp, clean, coarse sand, water washed, free from clay, salts and organic matter, and in accordance with CAN/CSA A179 "Mortar and Grout for Unit Masonry" for masonry sand is also acceptable.

3. Execution

3.1. INSTALLATION

- 3.1.1. All excavation and backfilling for all services shall be in accordance with Division 31.
- 3.1.2. Refer to Division 31 for rough excavation, removal of excavated material and backfill.
- 3.1.3. Protection:
 - .1 Provide protection to existing structures and services. Be responsible for rectifying any damage to existing structures and services resulting from this operation.
- 3.1.4. Excavation in Soil:
 - .1 Where rough excavation is carried out by Division 31, perform all layout Work for trenches required under this Division, including verification of trench depths and slopes. Work in close cooperation with excavating trades that remove subgrade to within 6 in. (150 mm) of the correct and final trench depth.
 - .2 Perform the final excavation to the correct trench invert to permit proper bedding as detailed in the Standard Drawings. Excavation carried below the correct inverts shall be backfilled with 2000 psi (13.5 MPa) concrete to the underside of the pipe lines, unless otherwise directed in writing.
- 3.1.5. Excavation in Rock:
 - .1 All excavation in rock is included under a separate Section, and is taken to a minimum of 150 mm (6 in.) below the correct pipe invert. This Division shall use a bedding material as detailed in the Standard Details to the correct trench invert.
- 3.1.6. Backfilling
 - Backfill with sand from the bottom of the trench or excavation up to a point 300 mm (12 in.) above the top of service line or appurtenance. Backfill pipe trenches with sand to a depth 300 mm (12 in.) above the pipe. The sand shall be thoroughly tamped around and over the pipes in 150 mm (6 in.) layers.
 - .2 Backfill up to top of subgrade.
 - .3 Backfill the remainder of trench or excavation up to top of subgrade or bottom of floor slabs on grade.

END OF SECTION

20 05 83.00 Sleeves and Escutcheons

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Firestopping and smoke seals within mechanical assemblies (i.e. inside ducts, dampers, etc.) with the exception of sleeves shown for future use installed in fire or smoke rated partitions shall be the responsibility of Mechanical Division. All other firestopping and smoke seals of mechanical services are part of Mechanical Division.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Sleeves passing through stud partitions shall be 0.75 mm (0.0299 in. - 22 GSG) steel.

2.1.2. Sleeves passing through concrete or masonry partitions and floors shall be Schedule 40 steel pipe.

2.1.3. Sleeves passing through floors in finished areas and concealed spaces may be sheet metal where additional protection is provided to prevent water from passing freely (i.e. housekeeping pad).

2.1.4. Sleeves for pipes passing through exterior foundation walls shall be pre-manufactured molded non-metallic HDPE equal to GPT Industries/Garlock Century-Line. Each sleeve assembly shall have end caps manufactured of the same material as the sleeve and installed at each end to prevent deformation during the concrete pour.

.1 The annular space between the service pipe and the sleeve shall be a modular EPDM seal element, reinforced nylon polymer pressure plates, joined with ASTM B633 "Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel" carbon steel bolts with zinc dichromate and corrosion inhibiting coating equal to GPT Industries/Garlock Link-Seal Model C wall seal.

.2 A reinforced concrete bridge shall be installed between the wall and the adjacent undisturbed soil.

2.1.5. Firestopping and smoke seal systems shall be in accordance with CAN/ULC-S115 "Standard Method of Fire Tests of Firestop Systems," CAN/ULC-S101 "Standard Methods of Fire Endurance Tests of Building Construction and Materials," ASTM E119 "Standard Test Methods for Fire Tests of Building and Construction Materials" and ASTM E814 "Standard Test Method for Fire Tests of Penetration Firestop Systems."

.1 Unless noted otherwise, "F" and "T" ratings are required. Provide "F" rating and "FT" rating that both equal or exceed the fire-resistance rating of the fire separation.

- .2 Systems shall be asbestos free and maintain an effective barrier against flame, smoke, and gases in accordance with CAN/ULC-S115 and shall not exceed opening sizes for which they are intended.
 - .3 Firestopping and smoke seals at openings around mechanical services shall be an elastomeric seal for sound and vibration control.
 - .4 Fire resistance rating of firestopping assembly shall not be less than the fire resistance rating of surrounding floor or wall assembly.
 - .5 Service penetration assemblies shall be ULC certified in accordance with CAN/ULC-S115 and listed in ULC Guide No. 40 U19.
 - .6 Service penetration firestop components shall be ULC certified in accordance with CAN/ULC-S115 and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15.
 - .7 Firestopping and smoke seals shall be by Hilti, Tremco/Royal Quickstop, STI Firestop or 3M.
 - .8 Firestop Products shall be mold and mildew resistant.
- 2.1.6. Escutcheons shall be satin finish stainless steel or satin finish chrome or nickel plated brass, with non-ferrous set screws. Do not use stamped steel split plates. Split cast plates with screw locks may be used. For escutcheons for plumbing fixtures refer to Section 22 42 00.00 - FIXTURES AND TRIM.
- 2.1.7. Provide adequate bracing for support of sleeves during concrete and masonry Work. For floors and walls with a fire resistance rating, build fire damper assemblies into structure to attain fire rated construction, in a manner acceptable to the governing authorities.
- 2.1.8. Cover exposed duct sleeves in finished areas with 1.42 mm (0.0561 in. - 18 GSG) galvanized sheet steel in the form of duct collars. Fix in position with non-ferrous metal screws.
- 2.1.9. Counter flashing for roof penetrations shall be commercial quality galvanized sheet steel to ASTM A653/A653M "Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process," 0.70 mm (0.0276 in. - 24 GSG) minimum thickness, Z275 275 zinc coated by hot dip process.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Arrange for all chases and formed openings in walls and floors as required by the Mechanical Division for the mechanical services. These chases and openings shall not be larger than necessary to accommodate the equipment and services. Advise on these requirements well in advance, before the concrete is poured and the walls are built. All necessary sleeves and inserts shall be supplied by this Division.
- 3.1.2. Chases and openings not located in accordance with the above provisions shall be made at the expense of this Division. Cutting of structural members shall not be permitted without specified written acceptance of the Engineer's Representative.
- 3.1.3. Provide sleeves for all service penetrations through walls, partitions, floor slabs, plenums and similar barriers.
- 3.1.4. Sleeves shall be sized to maintain insulation and vapour barrier around all pipes and ducts for all service penetrations. Coordinate thickness requirements with Section 20 07 00.00 - INSULATION.
- 3.1.5. For sleeves through barriers without a fire resistance rating, for non-insulated pipe, fill the annular space between the service and the sleeve with insulation as specified in Section 20 07 00.00 - INSULATION and caulk around the edges with sealant.

- 3.1.6. Firestopping and smoke seal material and components shall be installed in accordance with the ULC Listing and manufacturer's written instructions. Examine the sizes and conditions of the cavities to be filled to determine the correct thicknesses and installation of materials. All substrates and surfaces in contact with firestopping materials shall be dry and prepared in accordance with the Manufacturer's written instructions at appropriate ambient conditions.
- 3.1.7. Where holes are core drilled in existing structures, sleeves shall be provided as specified complete with a combination puddle/anchor flange bolted to the floor. Seal watertight between the flange and the floor.
- 3.1.8. Provide escutcheons at all penetrations of piping into finished areas, and at insulated pipes, make the escutcheons large enough to fit around the insulation.
- 3.1.9. Counter flash vertical duct penetrations through roof at intersection of roof curb and duct.
- 3.1.10. Extend sleeves a minimum of 50 mm (2 in) above floor and seal water tight to prevent seeping to the floor below. Sleeves passing through housekeeping pads are permitted to be flush with the top of the housekeeping pad.

END OF SECTION

20 05 88.00 Cutting and Patching

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Openings required for mechanical services for new construction shall be in accordance with Section 20 05 83.00 - SLEEVES AND ESCUTCHEONS. This Section shall apply for openings required in existing construction or where sleeves for mechanical services have been omitted in new construction in error.

1.1.3. Include for all cutting and patching for all mechanical services for holes and openings with dimensions up to 200 mm (8 in.) in size and related patching. Perform cutting and patching Work in accordance with requirements of Section 01 60 00.00 - PROJECT FORMS.

1.1.4. Cutting and Patching shall be in accordance with Section 01 60 00.00 - PROJECT FORMS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. All services and materials used for the cutting and patching shall meet all requirements specified in Section 01 60 00.00 - PROJECT FORMS, and shall be carried out by professional workers experienced in the cutting and patching Work to be done.

3. Execution

3.1. INSTALLATION

3.1.1. Locate all openings in non-structural elements requiring cutting and patching in cooperation with the applicable Trades in a timely manner to avoid unnecessary cutting. All openings shall be shown on drawings and submitted to the Engineer's Representative for review. No holes through structure shall be permitted prior to review by the Structural Engineer's Representative.

3.1.2. Core drilling for individual services shall be by this Division. Cut all openings no larger than is required for the services.

3.1.3. Locate all openings in structural elements requiring cutting and patching (concrete walls or floors) and x-ray the structure to obtain Structural Engineer's Representative's approval prior to cutting or core drilling of structure. Make adjustments to location of openings as required to minimize cutting of rebar and completely avoid electrical conduit.

.1 Cut holes through slabs or walls only.

.2 Do not cut holes through beams.

.3 Holes to be cut are 200 mm (8 in.) diameter or smaller only.

- .4 Maintain at least 100 mm (4 in.) clear from all beam faces. Space at least 3 hole diameters on Centre.
 - .5 For holes that are required closer than 25% of slab span from the supporting beam face, use cover meter above the slab to clear slab top bars.
 - .6 For holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars.
 - .7 X-rays shall be performed by a qualified technician, in a safe manner and in accordance with all applicable regulations governing this activity.
- 3.1.4. Obtain written approval from the Structural Engineer's Representative before cutting or core drilling openings or holes.
- 3.1.5. Patch all openings after services have been installed to match the surrounding finishes.

END OF SECTION

20 07 00.00 Insulation

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Provide Shop Drawings with technical data on all types of insulation to be installed, in accordance with Section 20 05 03.00 – SHOP DRAWINGS.

1.2.2. Provide two samples of each type of insulation indicating where each is to be used, and a sample of a typical vapour barrier dam, where vapour barrier dams are called for: in Part 3 or on the Drawings. Samples shall be mounted on boards. One shall be kept at the Contractor's site office and the other shall be turned over to the Engineer's Representative.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. GENERAL

2.1.1. Provide insulation and jacket systems that are fire retardant, with a flame-spread rating not to exceed 25 and a smoke developed classification not to exceed 50, when tested in accordance with CAN/ULC S102 "Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies."

2.1.2. For indoor applications, provide insulation systems (insulation, jackets, adhesives, coatings, etc.) that are Certified under the UL GREENGUARD Certification Program for low chemical and particle (volatile organic compounds (VOC)) emissions.

2.2. PIPE INSULATION

2.2.1. Type P1 - Inorganic mineral fibre: glass wool, rock wool, or slag wool.

.1 To ASTM C547 "Standard Specification for Mineral Fiber Pipe Insulation."

.2 Rigid, pre-formed, with pressure sensitive longitudinal adhesion strip.

.3 Reinforced all service jacket (ASJ) vapour retarder.

.4 Suitable for temperature range of pipe application in question.

.5 Acceptable manufacturers:

.1 Johns Manville

.2 Knauf

.3 Manson

.4 Owens-Corning

2.2.2. Type P2 - Inorganic mineral fibre: rock wool, or slag wool.

- .1 To ASTM C547 "Standard Specification for Mineral Fiber Pipe Insulation."
 - .2 Rigid, pre-formed, with pressure sensitive longitudinal adhesion strip. Chopped fibre moulded is not acceptable.
 - .3 Reinforced all service jacket (ASJ) vapour retarder.
 - .4 Suitable for temperature range of pipe application in question.
 - .5 Acceptable manufacturers:
 - .1 Knauf
 - .2 Rockwool
- 2.2.3. Type P3 - Closed cell flexible elastomeric:
- .1 To ASTM C534 "Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form."
 - .2 Preformed, with self closing adhesion strips.
 - .3 Suitable for temperature range of pipe application in question.
 - .4 UV resistant with protective jacket/cladding where used outdoors.
 - .5 Adhesive for both surfaces to be joined.
 - .6 Acceptable manufacturers:
 - .1 Armacell
- 2.2.4. Type P4 - Inorganic rock wool mineral fibre pipe wrap:
- .1 To ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications."
 - .2 Flexible blanket, with foil scrim kraft (FSK) facing or reinforced all service jacket (ASJ) vapour barrier.
 - .3 Suitable for temperature range of pipe application in question.
 - .4 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Rockwool
- 2.2.5. Type P5 - Closed cell cellular glass:
- .1 To ASTM C552 "Standard Specification for Cellular Glass Thermal Insulation" and ASTM C1639 "Standard Specification for Fabrication Of Cellular Glass Pipe And Tubing Insulation."
 - .2 Acceptable manufacturer:
 - .1 Owens-Corning - Foamglas
- 2.2.6. Type P6 - Fire resistant pipe insulation:
- .1 Except where other methods of fire rating are shown on the Drawings and provided that the local authority having jurisdiction is in agreement, provide CL4Fire fire wrap system for natural gas piping, fuel oil piping, standpipes, or other pipes requiring a fire rating and employ a fire wrap system listed for the specific piping application and fire rating in question. Provide fire wrap complete with CCMC Canadian code compliance evaluation approval.
- 2.2.7. Type P7 - Hydrous calcium silicate high temperature insulation:
- .1 To ASTM C533 "Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation."
 - .2 Rigid, split formed, moulded insulation.

- .3 Asbestos free, non-combustible.
- .4 Abuse-resistant, 230 kg/cu.m. (14 lbs/cu.ft.) density.
- .5 Suitable for temperature range up to 538 Deg. C (1000 Deg. F).
- .6 Acceptable manufacturer:
 - .1 Johns Manville – Thermo-12 Gold

2.3. DUCT INSULATION

2.3.1. Type D1 - Inorganic mineral fibre blanket - glass wool, rock wool, or slag wool:

- .1 To ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications."
- .2 Flexible blanket, with foil scrim kraft (FSK) facing jacket vapour barrier.
- .3 Density: 24 kg/cu.m. (1.5 lbs/cu.ft.).
- .4 Suitable for temperature range of duct application in question.
- .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Rockwool

2.3.2. Type D2 - Inorganic mineral fibre board - glass wool, rock wool, or slag wool:

- .1 To ASTM C612 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation."
- .2 Semi-rigid board, with factory applied foil scrim kraft (FSK) facing jacket vapour barrier.
- .3 Suitable for temperature range of duct application in question.
- .4 Density: 48 kg/cu.m. (3 lbs/cu.ft.).
- .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Owens-Corning
 - .4 Rockwool

2.3.3. Type D3 - Closed cell flexible elastomeric:

- .1 To ASTM C534 "Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form."
- .2 Preformed.
- .3 Suitable for temperature range of duct application in question.
- .4 UV resistant with protective jacket/cladding where used outdoors.
- .5 Adhesive for both surfaces to be joined.
- .6 Acceptable manufacturers:
 - .1 Armacell

2.3.4. Type D4 - Extruded polystyrene (XPS):

- .1 To ASTM C578 "Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation" and CAN/ULC S701.1 "Thermal Insulation, Polystyrene Boards."
- .2 Rigid, formed into board insulation.

- .3 Suitable for temperature range of duct application in question.
 - .4 Acceptable manufacturers:
 - .1 Dupont
 - .2 Owens-Corning
- 2.3.5. Type D5 - Fire resistant duct insulation:
- .1 To meet the requirements of NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations."
 - .2 To meet the fire resistance rating indicated on the Drawings or 2 hours.
 - .3 Complete with all manufacturer's standard fastenings, including (where applicable) aluminum foil tape, filament tape, banding materials, pins, cup-head weld pins, and speed clips for a ULC listed installation.
 - .4 Acceptable manufacturers:
 - .1 3M - Fire Barrier Duct Wrap
 - .2 CL4Fire
 - .3 Unifrax Corporation – FyreWrap
- 2.4. EQUIPMENT INSULATION
- 2.4.1. Type E1 - Inorganic mineral fibre blanket - glass wool, rock wool, or slag wool:
- .1 To ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications."
 - .2 Blanket, foil faced.
 - .3 Suitable for temperature range of equipment application in question.
 - .4 Density: Minimum 12 kg/cu.m. (0.75 lbs/cu.ft.).
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Manson
 - .4 Owens-Corning
- 2.4.2. Type E2 - Inorganic mineral fibre blanket - glass wool, rock wool, or slag wool:
- .1 To ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications."
 - .2 Blanket, with foil scrim kraft (FSK) facing jacket or all service jacket (ASJ), vapour barrier.
 - .3 Suitable for temperature range of equipment application in question.
 - .4 Density: Minimum 24 kg/cu.m. (1.5 lbs/cu.ft.).
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Manson
 - .4 Owens-Corning
- 2.4.3. Type E3 - Inorganic mineral fibre blanket - glass wool, rock wool, or slag wool:

- .1 To ASTM C553 "Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications."
 - .2 Flexible blanket, with foil scrim kraft (FSK) facing jacket or all service jacket (ASJ), vapour barrier.
 - .3 Density: minimum 48 kg/cu.m. (3 lbs/cu.ft.).
 - .4 Suitable for temperature range of equipment application in question.
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Owens-Corning
 - .4 Rockwool
- 2.4.4. Type E4 - Inorganic mineral fibre board - glass wool, rock wool, or slag wool:
- .1 To ASTM C612 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation."
 - .2 Semi-rigid board, with factory applied foil scrim kraft (FSK) facing jacket vapour barrier.
 - .3 Suitable for temperature range of equipment application in question.
 - .4 Density: minimum 48 kg/cu.m. (3 lbs/cu.ft.).
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Knauf
 - .3 Owens-Corning
 - .4 Rockwool
- 2.4.5. Type E5 - Inorganic mineral fibre board - glass wool, rock wool, or slag wool:
- .1 To ASTM C612 "Standard Specification for Mineral Fiber Block and Board Thermal Insulation."
 - .2 Semi-rigid board, with factory applied foil scrim kraft (FSK) facing jacket vapour barrier.
 - .3 Suitable for temperature range of equipment application in question.
 - .4 Density: minimum 128 kg/cu.m. (8 lbs/cu.ft.).
 - .5 Acceptable manufacturers:
 - .1 Johns Manville
 - .2 Owens-Corning
 - .3 Rockwool
- 2.4.6. Type E6 - Closed cell flexible elastomeric:
- .1 To ASTM C534 "Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form."
 - .2 Self adhering roll sheets.
 - .3 Suitable for temperature range of equipment application in question.
 - .4 UV resistant with protective jacket/cladding where used outdoors.
 - .5 Acceptable manufacturers:
 - .1 Armacell
- 2.4.7. Type E7 - Stone wool high temperature insulation:

- .1 To ASTM C547 "Standard Specification for Mineral Fiber Pipe Insulation."
- .2 Moulded stone wool, non-combustible.
- .3 Suitable for operating temperatures up to 760 Deg. C.(1400 Deg. F).
- .4 Acceptable manufacturer:
 - .1 Rockwool – ProRox PS 980
- 2.4.8. Type E8 - Spun ceramic fibre blanket high temperature insulation:
 - .1 To ASTM C892 "Standard Specification for High-Temperature Fiber Blanket Thermal Insulation."
 - .2 Suitable for applications with temperatures from 538 Deg. C (1000 Deg. F) to 1345 Deg. C (2450 Deg. F).
 - .3 Nominal density:128 kg/cu.m. (8 lbs/cu.ft.).
 - .4 Acceptable manufacturers:
 - .1 Nutech - MaxWool spun ceramic fibre blanket.
- 2.4.9. Type E9 - Spun low bio-persistent (LBP) fibre blanket high temperature insulation:
 - .1 To ASTM C892 "Standard Specification for High-Temperature Fiber Blanket Thermal Insulation."
 - .2 Suitable for applications with temperatures up to 1100 Deg. C (2000 Deg. F).
 - .3 Nominal density: 128 kg/cu.m. (8 lbs/cu.ft.).
 - .4 Acceptable manufacturer:
 - .1 Nutech – Supermag HI low-biopersistence spun blanket.
- 2.4.10. Type E10 - Hydrous calcium silicate high temperature insulation:
 - .1 To ASTM C533 "Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation."
 - .2 Rigid, split formed, moulded insulation.
 - .3 Asbestos free, non-combustible.
 - .4 Abuse-resistant, 230 kg/cu.m. (14 lbs/cu.ft.) density.
 - .5 Suitable for temperature range up to 538 Deg. C (1000 Deg. F).
 - .6 Acceptable manufacturer:
 - .1 Johns Manville – Thermo-12 Gold
- 2.5. JACKETS
- 2.5.1. All service jacket (ASJ)
 - .1 As indicated in insulation types above.
- 2.5.2. Foil skim kraft (FSK)
 - .1 As indicated in insulation types above.
- 2.5.3. Insulation Jacketing System:
 - .1 Multi-layered, reinforced laminate jacketing tape with acrylic pressure sensitive adhesive.
 - .2 Zero permeability; self-adhesive; UV and weather resistant.
 - .3 Colour: Natural aluminum or white, as chosen at Shop Drawing stage.
 - .4 Finish: flat or embossed, as chosen at Shop Drawing stage.

- .5 Acceptable manufacturers:
 - .1 3M – VentureClad Insulation Jacketing System 1577 Series
 - .2 3M – VentureClad Heavy Duty Jacketing System 1579 Series
- 2.5.4. Canvas jacket:
 - .1 ULC listed plain weave cotton fabric insulation jacket.
 - .2 Weight of canvas: 220 g/sq.m (6 oz/sq.yd.).
 - .3 Complete with two coats of fire retardant lagging finish.
- 2.5.5. Polyvinyl Chloride (PVC) jacket:
 - .1 Pre-moulded PVC covers.
 - .2 Pre-moulded PVC elbows and fittings.
 - .3 Minimum thickness: 20 mil.
 - .4 Colour: white or coloured as chosen at Shop Drawing stage.
 - .5 Tape: vinyl, pressure sensitive, colour matched.
 - .6 Sealed with adhesive.
- 2.5.6. Aluminum jacket:
 - .1 Finish: smooth.
 - .2 Minimum thickness: 0.41 mm (0.016 in.).
 - .3 Factory applied polysurlyn moisture barrier laminated to inside surface of jacket.
 - .4 Longitudinal and circumferential slip joints.
- 2.5.7. Stainless Steel (SS) jacket:
 - .1 Grade: 304.
 - .2 Finish: smooth.
 - .3 Minimum thickness: 0.25 mm (0.01 in.).
 - .4 Factory applied polysurlyn moisture barrier laminated to inside surface of jacket.
 - .5 Longitudinal and circumferential slip joints.
- 2.6. SECUREMENT
- 2.6.1. Banding
 - .1 Aluminum or Stainless steel.
- 2.6.2. Tie Wire
 - .1 Stainless steel.
 - .2 Minimum 1.3 mm (16 gauge).
 - .3 Twisted ends.
- 2.6.3. Corner beads and channels at floor line:
 - .1 Minimum 0.4 mm (28 gauge) galvanized sheet metal.
- 2.6.4. As per insulation / jacket manufacturer's written installation instructions.
- 2.7. CEMENTS AND ADHESIVES
- 2.7.1. Where cements or adhesives are required, provide those that are compatible with insulation and jacket, per insulation and jacket manufacturer's written recommendations / instructions.

- 2.7.2. Fire retardant lagging coating:
 - .1 Chil Seal CP-50A by Childers Products Company or Henry equivalent.
- 2.7.3. Vapour barrier dam:
 - .1 CHIL-PERM CP-30 with fibreglass cloth reinforcing.
- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Install insulation in accordance with the manufacturer's written installation instructions unless noted otherwise.
 - 3.1.2. Insulation thicknesses and conductivities shall meet or exceed the minimum standards set out in ASHRAE 90.1 "Energy Standard for Buildings except Low-rise Residential Buildings" and in National Energy Code of Canada for Buildings (NECB), (refer to Table 2 below), and as specified herein for the services covered.
 - 3.1.3. Apply insulation to clean, dry surfaces only while ambient temperature is at least 10 Deg. C. (50 Deg. F.).
 - 3.1.4. Commence application of insulation following required testing of piping, ductwork, and apparatus where such items are to be covered. Do not commence insulation installation until testing report is submitted to Engineer's Representative and is reviewed by Engineer's Representative without requesting a resubmit.
 - 3.1.5. Where pipes and ducts are specified to be insulated, insulate complete piping system and duct system with no gaps in insulation.
 - 3.1.6. Protect insulation and pipe from moisture ingress where insulation is installed exterior to the building.
 - 3.1.7. Utilize oversized hangers and pipe supports where pipes are installed exterior to the building and are to be insulated. Hangers and supports to support assembly on the outside of the insulation, so as to protect insulation and pipe from water damage due to ambient conditions.
 - 3.1.8. Where vapour barrier dams are called for, terminate the insulation and seal the vapour barrier to the pipe or ductwork using a mesh embedded in a vapour barrier mastic. Provide dams at valves, fittings used for servicing, groups of other types of fittings, irregular shaped objects at floor and wall penetrations, and at 15 m (50 ft.) intervals of straight pipe or straight ductwork for the following services: water piping that is less than 26.7 deg. C. (80 deg. F.), including but not limited to the following:
 - .1 Domestic cold water piping
 - .2 Chilled drinking water piping
 - .3 Chilled water piping
 - .4 Glycol piping
 - .5 Spray coil piping
 - .6 Dual temperature piping
 - .7 Condenser water pipe piping and
 - .8 Exterior ductwork
 - 3.1.9. Terminate insulation on pipes passing through fire rated walls or floors, and fit tight to the fire stop material.

- 3.1.10. Irregular shaped objects such as strainers, pipe system filters, cyclone separators, blowdown valves and other accessories requiring servicing, on insulated piping, shall be insulated with removable caps or sections. All edges shall be sealed between pipe and vapour barrier and held in place with stainless steel straps. Finish all insulation smooth, making the outline of pipe insulation a true circular and concentric shape. Shape the outline of fitted insulation to blend with adjacent covering.
- 3.1.11. On piping systems specified to be insulated, include insulation on valves, flanges, couplings and unions.
- 3.1.12. Do not use staples to secure joints of insulation jackets.
- 3.1.13. Where tie wires are used, install on maximum 305 mm (12 in.) centres.
- 3.1.14. Install insulation jackets with minimum 50 mm (2 in.) laps.
- 3.1.15. Provide insulation and jacket systems in accordance with Table 1 below:

TABLE 1: INSULATION AND JACKET SYSTEMS

Pipe Application	Insulation	Thickness	Jacket
Piping services that will be painted	See table contents below	See table contents below	Do not use PVC.
Pipe insulation exposed to view / not concealed, where being painted	See table contents below	See table contents below	Canvas pasted on
Pipe insulation exposed to view / not concealed, where NOT being painted	See table contents below	See table contents below	Canvas pasted on or PVC
Pipes that are electrically heat traced	Do not use Type P3	See table contents below	See table contents below
Where pipes are installed outdoors, provide pipe coatings in accordance with Section 23 21 13.23 – Piping, Valves & Fittings (Except Plumbing).	See table contents below	See table contents below	See table contents below
Hot fluid such as heating water services, heating glycol, low pressure steam and condensate piping, etc.	Type P1	Per Table 2	Per insulation type; for high temperature heating water do not use PVC; see Section 23 21 13.23 for more info on temperatures.
Domestic hot water piping	Type P1	Per Table 2	Per insulation type
Refrigerant liquid and suction piping	Type P3	25 mm (1 in.), unless a greater thickness is required by the manufacturer's written instructions.	Per insulation type

Domestic cold water and chilled drinking water piping. In residential suite applications, downstream of the suite shut off valve, PEX piping used for domestic cold water does not require insulation.	Type P1 or P3	Per Table 2 domestic cold water requirements	Per insulation type
First 4500 mm (15 ft.) of standpipe and/or sprinkler main	Type P1 or P3	12 mm (1/2 in.)	Per insulation type
Chilled water	Type P1 or P3	Per Table 2	Per insulation type
Dual temperature water or glycol	Type P1 or P3	Per Table 2	Per insulation type
Ground source condenser water system piping – consider as dual temperature service.	See table contents below	See table contents below	See table contents below
Dual temperature condenser water piping	Type P1 or P3	Per Table 2	Per insulation type
Chemical feed piping for evaporative fluid cooler basin, where piping is outdoors	Type P3	Per Table 2	Per insulation type
Piping in air handling or air conditioning units	Type P3	25 mm (1 in.)	Per insulation type
Piping serving pumps for cold fluid systems such as chilled water, domestic water, etc. and located inside air handling or air conditioning units	Type P3	25 mm (1 in.)	Per insulation type
Drainage piping 75 mm (3 in.) and smaller as indicated below: Storm drainage: roof drain sump; all horizontal or sloping storm piping; all elbows connecting the horizontal storm drainage piping to the vertical leaders; and where the roof drain is less than 3000 mm (10 ft.) horizontally from the vertical leader, insulate the first 3000 mm (10 ft.) of pipe length (horizontal and vertical) closest to the roof drain.	Type P1 or P3	12 mm (1/2 in.)	Per insulation type

Sanitary drainage: sanitary drainage pipes from urinals, direct and indirect drains from drinking fountains, floor drains from air conditioning apparatus, all horizontal drainage carrying chilled condensate, all piping passing through areas with relative humidity of 70% or higher, and sanitary drainage pipe from barrier free lavatories.			
Drainage piping larger than 75 mm (3 in.) as indicated below: Storm drainage: roof drain sump; all horizontal or sloping storm piping; all elbows connecting the horizontal storm drainage piping to the vertical leaders; and where the roof drain is less than 3000 mm (10 ft.) from the vertical leader insulate the first 3000 mm (10 ft.) of pipe closest to the roof drain and the exposed portion of the roof drain. Sanitary drainage: sanitary drainage pipes from urinals; direct and indirect drains from drinking fountains; floor drains from air conditioning apparatus; all horizontal drainage carrying chilled condensate; all piping passing through areas with relative humidity of 70% or higher; and sanitary drainage pipe from barrier free lavatories.	Type P1 or P3	25 mm (1 in.)	Per insulation type
Electrical heat traced piping – insulated for the entire length of piping	As specified for the service being traced; for services not specifically designated, insulate as specified for heating water	For pipes 250 mm (10 in.) and smaller: minimum 38 mm (1-1/2 in.) or thicker as required for the service in question.	As specified for the service being traced

		For pipes 300 mm (12 in.) and larger: minimum 50 mm (2 in.) or thicker as required for the service in question. Thickness of insulation over fittings, valves, and other appurtenances to match the pipe insulation. Provide thicker insulation as required by heat tracing manufacturer's installation requirements.	
Duct Application	Insulation	Thickness	Jacket
Flexible duct connections do not require insulation except where a factory applied insulation has been specified with the flexible duct connection.	See ductwork spec	See ductwork spec	See ductwork spec
Exposed insulation in mechanical rooms	See table contents below	Increase thickness as necessary to give 12 mm (1/2 in.) thickness over flanges and angles.	See table contents below
Ductwork internal to the building within conditioned spaces	Type D2	25 mm (1 in.)	Per insulation type
Ductwork in conditioned concealed spaces and on round duct smaller than 600 mm (24 in.)	Type D1	38 mm (1-1/2 in.)	Per insulation type
Ductwork external to the building	Type D3 or D4	2 layers of 50 mm (2 in.)	Per insulation type for Type D3 or Insulation jacketing system for Type D4

		Provide sloped extruded polystyrene insulation support on top of ductwork to maintain slope at a minimum of 5%. Cover all flanges by a minimum of 12 mm (1/2 in.).	
Apparatus casings	As per connected ductwork, see table above	As per connected ductwork, see table above	As per connected ductwork, see table above
Outside air plenums and mixed air plenums.	See indoor ductwork above	Thickness to suit minimum RSI-2.12 (R-12) for plenums exposed to outside air.	See indoor ductwork above
Outdoor air ductwork and mixed air ductwork, including ducts to and from independent heat recovery units (ERW, HRV, etc.).	See indoor ductwork above	Thickness to suit minimum RSI-2.12 (R-12).	See indoor ductwork above
Heating and cooling coil sections of ductwork and plenums.	Per indoor ductwork	Per indoor ductwork	Per indoor ductwork
Casings of supply fans in equipment rooms.	Per indoor ductwork	Per indoor ductwork	Per indoor ductwork
Supply ductwork in equipment rooms.	Per indoor ductwork	Per indoor ductwork	Per indoor ductwork
Exhaust and relief air: ductwork, plenums, and/or casings, from 1500 mm (60 in.) upstream of shut-off dampers and from dampers to connection to exterior wall or roof.	Per indoor ductwork	Thickness to suit minimum RSI-2.12 (R-12).	Per indoor ductwork
Exhaust air ductwork from independent heat recovery units (ERW, HRV, etc.) up to connection to exterior wall or roof.	Per indoor ductwork	Thickness to suit minimum RSI-2.12 (R-12).	Per indoor ductwork

Exhaust, relief, supply, and return air: ductwork, plenums and/or casings, through non-air conditioned or unheated internal space.	Per indoor ductwork	Use 50 mm (2 in.) thickness.	Per indoor ductwork
All supply ductwork from fans to air outlets (e.g. diffusers, grills, etc.)	Per indoor ductwork	Per indoor ductwork	Per indoor ductwork
Silencers and fan capacity monitors.	Insulate to suit service and location.	To suit service and location.	To suit service and location.
All supply ductwork from VAV box for variable volume systems up to and including terminal grill or diffuser.	Per indoor ductwork	Per indoor ductwork	Per indoor ductwork
Equipment Application	Insulation	Thickness	Jacket
Domestic hot water tanks	Type E2, wired on	50 mm (2 in.)	Canvas
Heating water tanks / thermal buffer tanks	Type E2, wired on	50 mm (2 in.)	Canvas
Shell and tube heat exchangers	Type E2, wired on	50 mm (2 in.)	Canvas
Radiant heating panels	Type E1	25 mm (1 in.)	Per insulation type
Cold water service: valves, water meters, drain valves, vent connections, thermometer wells, pressure gauges, and other irregular shaped objects	Type E6	To suit service, per Table 2	Per insulation type
Hot water service <= 66 deg. C. (150 deg. F.): valves, water meters, drain valves, vent connections, thermometer wells, pressure gauges, and other irregular shaped objects	Type E6 or E2	To suit service, Per Table 2	Per insulation type
Hot water service > 66 deg. C. (150 deg. F.): valves, water meters, drain valves, vent connections, thermometer wells, pressure gauges, and other irregular shaped objects	Type E2	To suit service, Per Table 2	Per insulation type
Chilled water storage tanks / thermal storage tanks / dual temperature tanks; including legs/supports	Type E6	50 mm (2 in.)	Per insulation type

Pumps for chilled water, spray coils, and domestic water	Type E6	25 mm (1 in.)	Per insulation type
Equipment internal to the building within conditioned spaces	Type E4	25 mm (1 in.)	Per insulation type
Chillers	Type E6 Insulate in accordance with the manufacturer's printed insulation instructions, and insulate all components shown or noted in the instructions. Insulate evaporator, water heads, suction connections and auxiliary water piping of centrifugal water chillers. Insulate auxiliary water piping as per chilled water piping. Provide removable sections of insulation at all components that require servicing, and secure with stainless steel straps.	25 mm (1 in.)	Per insulation type
Plate type heat exchangers with hot surfaces	Type E4	25 mm (1 in.)	Enclose hot surfaces in a removable galvanized steel box. Construct box using flanged, bolted and gasketed joints, with sections removable for servicing the heat exchanger. Bolt box to floor base around the heat exchanger. Provide construction similar to built-up air plenums.

Plate type heat exchangers with cold surface	Type E6, installed in sections with all joints sealed. Also insulate in accordance with the manufacturer's printed insulation instructions. Insulate plate heat exchangers when both services are insulated.	25 mm (1 in.)	Per insulation type
Shell and tube heat exchangers <= 66 deg. C. (150 deg. F.), when service in the shell is insulated.	Type E6	25 mm (1 in.)	Per insulation type
Shell and tube heat exchangers > 66 deg. C. (150 deg. F.), when service in the shell is insulated.	Type E2	25 mm (1 in.)	Per insulation type
Unlisted generator exhaust systems, under 538 Deg. C. (1000 Deg. F.); confirm temperature rating of generator flue prior to insulation.	Type E10	Two layers of 50 mm (2 in.) with staggered joints, wired on.	Cover entire length of insulation with an aluminum jacket. Form expansion joints with slip joints extending 300 mm (12 in.) past the flange at each end of the joint.
Unlisted generator exhaust systems, under 538 Deg. C. (1000 Deg. F.); confirm temperature rating of generator flue prior to insulation.	Type E7	Two layers of 50 mm (2 in.) with staggered joints, wired on.	Cover entire length of insulation with an aluminum jacket. Form expansion joints with slip joints extending 300 mm (12 in.) past the flange at each end of the joint.
Unlisted generator exhaust systems, 538 Deg. C. (1000 Deg. F.) and greater; confirm temperature rating of generator flue prior to insulation.	Type E8 or E9, AND Type E7	Two layers of 25 mm (1 in.), Type E8 or E9, with staggered joints, AND one layer of 50 mm (2 in.) thick Type E7, wired on.	Cover entire length of insulation with an aluminum jacket. Form expansion joints with slip joints extending 300 mm (12 in.) past the flange at each end of the joint.
Site fabricated breaching, up to and including connection to chimney stack. Insulate all breaching, except for double walled insulated gas vents, from all boilers and other equipment up to the chimney stack.	Type E7, secured with pins and covered with expanded metal lath. Apply insulation to permit expansion and contraction of breaching without damage to the insulation.	100 mm (4 in.) thick	Final finish consisting of two layers of cement, reinforced with canvas and trowelled smooth, to effect a uniform finish.

3.1.16. Hot Services

- .1 On hot services, insulate valves, fittings, couplings, unions, flanges and all other appurtenances through which the fluid passes, using mitred sections of preformed insulation of a thickness equal to the adjoining pipe insulation, and securely wire in place.
- .2 For domestic hot water piping, apply insulation with all joints butted firmly together, and bond securely, sealing flaps by pasting down to give a smooth finish.
- .3 Provide removable sections at access doors/manholes and all components requiring servicing.

3.1.17. Cold Services

- .1 Protect insulation by means of sheet steel shields at each hanger or support on the following:
 - .1 All sizes of chilled water
 - .2 All sizes of chilled glycol
 - .3 All sizes of spray coil
 - .4 All sizes of dual temperature
 - .5 All sizes of condenser water pipes
 - .6 Domestic cold water piping larger than 25 mm (1 in.)
- .2 Provide Type P5 closed cellular glass insulation inserts the full length of shields at all hangers and supports.
- .3 For domestic cold water piping 25 mm (1 in.) and less where hangers on cold water lines penetrate vapour barrier, ensure that the penetration is properly sealed with insulation and vapour barrier continued up hanger a further 75 mm (3 in.).
- .4 Where sheet metal shields are used, refer to Section 20 05 29.00 - HANGERS AND SUPPORTS.
- .5 On cold water service valves, water meters, drain valves, vent connections, thermometer wells, pressure gauges and other irregular shaped objects, cut and mitre insulation as necessary. Bond and seal edges of insulation to the adjacent surfaces.
- .6 Chilled water storage tanks: provide removable sections at access doors/manholes and all components requiring servicing.
- .7 Refer to the Table 2 for required insulation thicknesses.

3.1.18. Ductwork and Equipment

- .1 Butt join insulation and attach with pins and speed washers, one per 0.186 sq.m. (2 sq.ft.), but not more than 450 mm (18 in.) apart in any direction. Apply fire resistive adhesive in 100 mm (4 in.) wide strips on 300 mm (12 in.) centres. Seal all joints with adhesive and apply vapour barrier tape. Install pins of suitable length for the thickness of insulation and clip flush after final installation of washers. Tack weld pins to sheet metal.
- .2 On exposed insulation in mechanical rooms, provide corner beads to protect corners to a height of 2135 mm (84 in.) above floor and provide channels at floor line to finish off insulation on apparatus.
- .3 Coordinate with Sheet Metal Contractor to ensure duct insulation is applied prior to ductwork being installed to underside of slabs, beams or other services or behind other duct risers and shafts.

- 3.1.19. Apply fire resistant duct insulation directly onto the ductwork and plenums in strict accordance with the manufacturer's written instructions and Listing. Tested to CAN/ULC-S144 "Standard Method of Fire Resistance Test – Grease Duct Assemblies," ISO Standard 6944-1 "Fire containment - Elements of building construction - Part 1: Ventilation ducts," and ISO Standard 6944-2 "Fire containment - Elements of building construction - Part 2: Kitchen extract ducts" as a gypsum shaft alternative per NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations" guidelines.
- 3.1.20. Except where other methods of fire rating are shown on the Drawings, where fire wrap systems for pipes are acceptable to the local authority having jurisdiction, install fire wrap system, in accordance with the CCMC listing and the manufacturer's written instructions.

3.1.21. TABLE 2: MINIMUM PIPE INSULATION THICKNESS/PERFORMANCE (BASED ON ASHRAE 90.1 AND NATIONAL ENERGY CODE FOR BUILDINGS)

- .1 Comply with the more stringent (i.e. larger) minimum pipe insulation thickness when comparing ASHRAE 90.1 and National Energy Code for Buildings.
- .2 Minimum pipe insulation thickness - mm (in.)
 - .1 ASHRAE 90.1: Heating and Hot Water Systems (Steam, Steam Condensate, Hot-Water Heating, Domestic Water Systems, Heating Glycol, Other Heating)

Fluid Design Operating Temp. range deg. C. (deg. F.)	Insulation Conductivity		Nominal Pipe Diameter - mm (in.)					
	Conductivity W/(m-K) ((Btu-in.)/h-sq.ft. – deg. F.)	Mean Rating Temp deg. C. (deg. F.)	Runouts* <38.1 (<1.5)	<25.4 (<1)	25.4 to <38.1 (1 to <1-1/2)	38.1 to <101.6 (1-1/2 to <4)	101.6 to <203.2 (4 to <8)	≥203.2 (≥8)
Above 177	0.046 to 0.049	121	101.6	114.3	127.0	127.0	127.0	127.0
Above (350)	(0.32 to 0.34)	(250)	(4.0)	(4.5)	(5.0)	(5.0)	(5.0)	(5.0)
122-177	0.042 to 0.046	93	76.2	76.2	101.6	114.3	114.3	114.3
(251 to 350)	(0.29 to 0.32)	(200)	(3.0)	(3.0)	(4.0)	(4.5)	(4.5)	(4.5)
94-121	0.039 to 0.043	66	38.1	63.5	63.5	63.5	76.2	76.2
(201 to 250)	(0.27 to 0.30)	(150)	(1.5)	(2.5)	(2.5)	(2.5)	(3.0)	(3.0)
61-93	0.036 to 0.042	52	25.4	38.1	38.1	50.8	50.8	50.8
(141 to 200)	(0.25 to 0.29)	(125)	(1.0)	(1.5)	(1.5)	(2.0)	(2.0)	(2.0)
41-60	0.032 to 0.040	38	25.4	25.4	25.4	38.1	38.1	38.1
(105 to 140)	(0.22 to 0.28)	(100)	(1.0)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)

*For piping located in partitions within conditioned spaces, reduction per footnote to ASHRAE 90.1 table.

.2 National Energy Code for Buildings: Heating Systems (Steam, Steam Condensate, Hot Water Heating, Domestic Water Systems, Heating Glycol, Other Heating)

Fluid Design Operating Temp. range deg. C. (deg. F.)	Insulation Conductivity		Nominal Pipe Diameter - mm (in.)					
	Conductivity W/(m-deg. C) ((Btu-in.)/h-sq.ft. – deg. F.)	Mean Rating Temp deg. C. (deg. F.)	Runouts ^y ≤51 (2)	≤25.4 (<1)	32 to 51 (1-1/4 to 2)	64 to 102 (2-1/2 to 4)	≥127 (≥5)	Not used
Above 177	0.046 to 0.049	121	38.1	114	127	127	127	
Above (350)	(0.32 to 0.34)	(250)	(1.5)	(4.5)	(5.0)	(5.0)	(5.0)	
122-177	0.042 to 0.045	93	38.1	76.2	101.6	114	114	
(251 to 350)	(0.29 to 0.31)	(200)	(1.5)	(3.0)	(4.0)	(4.5)	(4.5)	
94-121	0.039 to 0.043	65	38.1	63.5	63.5	76.2	76.2	
(201 to 250)	(0.27 to 0.30)	(149)	(1.5)	(2.5)	(2.5)	(3.0)	(3.0)	
61-93	0.036 to 0.042	52	25.4	38.1	50.8	50.8	50.8	
(141 to 200)	(0.25 to 0.29)	(125)	(1.0)	(1.5)	(2.0)	(2.0)	(2.0)	
41-60	0.035 to 0.040	38	25.4	25.4	38.1	38.1	38.1	
(105 to 140)	(0.24 to 0.28)	(100)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)	

^yRefers to runouts to individual terminal units not exceeding 3.7 m in length.

.3 ASHRAE 90.1: Cooling Systems (Chilled Water, Brine, Refrigerant, Chilled Glycol, Dual Temperature Condenser Water (condenser water systems that may operate below 16 deg. C)) and Domestic Cold Water.

Fluid Design Operating Temp. range deg. C. (deg. F.)	Insulation Conductivity		Nominal Pipe Diameter - mm (in.)					
	Conductivity [W/(m-K)] [(Btu-in.)/h-sq.ft. – deg. F.]	Mean Rating Temp deg. C. (deg. F.)	Not used	<25.4 (<1)	25.4 to <38.1 (1 to <1-1/2)	38.1 to <101.6 (1-1/2 to <4)	101.6 to <203.2 (4 to <8)	≥203.2 (≥8)
4.4-16	0.030 to 0.039	24		12.7	12.7	25.4	25.4	25.4
(40-60)	(0.21 to 0.27)	(75)		(0.5)	(0.5)	(1.0)	(1.0)	(1.0)
<4.4	0.029 to 0.038	10		12.7	25.4	25.4	25.4	38.1
<(40)	(0.20 to 0.26)	(50)		(0.5)	(1.0)	(1.0)	(1.0)	(1.5)

.4 National Energy Code for Buildings: Cooling Systems (Chilled Water, Brine, Refrigerant, Chilled Glycol, Dual Temperature Condenser Water (condenser water systems that may operate below 16 deg. C)) and Domestic Cold Water.

Fluid Design Operating Temp. range deg. C. (deg. F.)	Insulation Conductivity		Nominal Pipe Diameter - mm (in.)					
	Conductivity [W/(m-deg. C)] [(Btu-in.)/h-sq.ft. – deg. F.]	Mean Rating Temp deg. C. (deg. F.)	Runouts ^y ≤51 (2)	≤25.4 (<1)	32 to 51 (1-1/4 to 2)	64 to 102 (2-1/2 to 4)	≥127 (≥5)	Not used
4-16	0.030 to 0.039	24	25.4	25.4	25.4	25.4	25.4	
(39-61)	(0.21 to 0.27)	(75)	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	
<4	0.030 to 0.039	24	25.4	25.4	38.1	38.1	38.1	
<(39)	(0.21 to 0.27)	(75)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)	

^yRefers to runouts to individual terminal units not exceeding 3.7 m in length.

END OF SECTION

20 08 00.01 Commissioning (with Commissioning Agent)

1. General

1.1. WORK INCLUDED

- 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2. Conform to Section 20 05 02.00 - AS-BUILT DRAWINGS.
- 1.1.3. Conform to Section 20 05 03.00 - SHOP DRAWINGS.
- 1.1.4. Conform to Section 20 08 03.00 - OPERATING AND MAINTENANCE INSTRUCTIONS.
- 1.1.5. Conform to Section 23 05 93.13 - TESTING AND BALANCING PIPING SYSTEMS.
- 1.1.6. Conform to Section 23 05 93.23 - TESTING AND BALANCING AIR SYSTEMS.
- 1.1.7. Conform to Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- 1.1.8. The commissioning process for the Mechanical Systems shall include:
 - .1 Verification that the installation meets the requirements of the Contract Documents.
 - .2 Verification that the system's performance meets the design intent.
 - .3 Provision of building operator training.
 - .4 Provision of as-built documentation, operating and maintenance manuals, and systems operating manuals.
- 1.1.9. The Contractor and the Commissioning Agent shall provide the services to complete the process. The execution portion of this Section defines the areas of responsibility.
- 1.1.10. Provide labour, equipment and material to conduct the Contractor commissioning process as outlined in this Section.
- 1.1.11. The Owner will hire a Commissioning Agent who will provide services identified in the Commissioning Agent articles within this Section.
- 1.1.12. On an on-going basis, advise the Engineer's Representative of the latest schedule for testing and commissioning. The Engineer's Representative may selectively attend at their discretion.
- 1.2. SUBMITTALS
- 1.2.1. Submittals requested in this Section shall be submitted in accordance with Section 20 05 03.00 – SHOP DRAWINGS.
- 1.3. WARRANTY
- 1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

- 2.1.1. The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests as specified in the Mechanical Sections. The Contractor shall advise the Commissioning Agent of instrumentation to be used and the dates the instruments were calibrated.

3. Execution

3.1. INSTALLATION

- 3.1.1. This Section describes the commissioning process to be performed by the Contractor. The process shall provide a high level of quality control during the construction.

- 3.1.2. The commissioning process shall consist of:

- .1 Shop Drawings/as-built drawings
- .2 Installation review and equipment verification
- .3 Plumbing and drainage system testing
- .4 Testing of piping systems
- .5 Balancing of piping systems
- .6 Testing of air systems
- .7 Balancing of air systems
- .8 Testing of equipment and systems
- .9 Building Automation System Commissioning
- .10 Commissioning Agent performance testing
- .11 Commissioning meetings
- .12 Operating and maintenance manuals
- .13 Training
- .14 Systems acceptance

3.2. INSTALLATION REVIEW AND EQUIPMENT VERIFICATION

- 3.2.1. Complete the equipment verification forms for each piece of equipment. Forward to the Commissioning Agent and Engineer's Representative for review and include in the operating and maintenance manuals.

3.3. TEST FORMS AND VERIFICATION FORMS

- 3.3.1. The Commissioning Agent will prepare a test form manual, which will contain a form for every test identified in the Specification. A copy of this manual will be given to the Contractor, the General Contractor and the Engineer's Representative.
- 3.3.2. Arrange for the forms to be signed by either the Authorities Having Jurisdiction or the Commissioning Agent where applicable.

- 3.4. PLUMBING AND DRAINAGE SYSTEM TESTING
 - 3.4.1. Test the plumbing and drainage system in accordance with Section 23 05 93.13 - TESTING AND BALANCING PIPING SYSTEMS.
 - 3.4.2. Notify the Building Inspector when systems are available for testing. Document all tests performed and arrange for the Building Inspector to sign the forms when tests completed.
- 3.5. TESTING OF PIPING SYSTEMS
 - 3.5.1. Test all piping systems in accordance with Section 23 05 93.13 - TESTING AND BALANCING PIPING SYSTEMS.
 - 3.5.2. Perform all tests in the presence of the Commissioning Agent.
- 3.6. TESTING OF AIR SYSTEMS
 - 3.6.1. Conform to Section 23 05 93.23 - TESTING AND BALANCING AIR SYSTEMS.
 - 3.6.2. Perform all tests in the presence of the Commissioning Agent.
- 3.7. TESTING OF EQUIPMENT AND SYSTEMS
 - 3.7.1. Conform to Section 20 08 03.00 - OPERATING AND MAINTENANCE INSTRUCTIONS.
 - 3.7.2. Engage the services of the manufacturer's technicians to test the equipment and associated systems. Have the technician record the results of the tests on the testing forms. Arrange for the tests to be witnessed by the Commissioning Agent. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms.
 - 3.7.3. Should equipment or systems fail a test, repeat the test after repairs or adjustments have been made. Arrange for these additional tests to be witnessed by the Commissioning Agent.
 - 3.7.4. Tests which have not been witnessed will not be accepted and must be repeated.
- 3.8. COMMISSIONING MEETINGS AND SCHEDULING
 - 3.8.1. The Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.
 - 3.8.2. The commissioning meetings shall occur during the regular construction meetings. The testing schedules and results of all tests shall be reviewed.
- 3.9. OPERATING AND MAINTENANCE MANUALS
 - 3.9.1. Conform to Section 20 08 03.00 - OPERATING AND MAINTENANCE INSTRUCTIONS.
 - 3.9.2. Submit Operating and Maintenance Manuals to Commissioning Agent for review.
- 3.10. OPERATOR TRAINING
 - 3.10.1. Conform to Section 20 08 03.00 - OPERATING AND MAINTENANCE INSTRUCTIONS.
 - 3.10.2. Conduct the training in a classroom and at the equipment or system.
 - 3.10.3. Training will begin when the operating and maintenance manuals have been reviewed by the Engineer's Representative without requesting a resubmission and have been delivered to the Owner.
 - 3.10.4. Submit a course outline to the Engineer's Representative and Commissioning Agent before training commences. Provide course documentation for up to eight people.
 - 3.10.5. Structure each training session to cover:

- .1 The operating and maintenance manual
 - .2 Operating procedures
 - .3 Maintenance procedures
 - .4 Trouble-shooting procedures
 - .5 Spare parts required
- 3.10.6. The training sessions will be scheduled and co-ordinated by the Commissioning Agent. The Commissioning Agent will digitally video record the sessions.
- 3.10.7. Provide training for the following systems:
- | System | Minimum Training Times |
|---------------------------------------|------------------------|
| Chillers | 4 hours |
| Cooling towers | 2 hours |
| Boilers | 2 hours |
| Air handling units | 2 hours |
| Life safety & fire protection systems | 2 hours |
| Water treatment systems | 2 hours |
| The mechanical system | 8 hours |
| Fuel oil system | 2 hours |
| Generator Ventilation System | 1 hour |
| BAS Controls System | Conform to 23 09 00.00 |
- 3.10.8. Refer to Section 23 09 00.00 - BUILDING AUTOMATION SYSTEMS (BAS).
- 3.10.9. As part of the training requirement for the mechanical systems, conduct a walk-through of the building. During the walk-through the Contractor shall:
- .1 Identify equipment
 - .2 Identify starters associated with equipment
 - .3 Identify valves and balancing dampers
 - .4 Identify access doors
 - .5 Review general maintenance of equipment
 - .6 Review drain locations in pipework systems
 - .7 Identify maintenance items
- 3.10.10. When each training session has been completed with the Owner's representatives, have the Commissioning Agent sign the associated form to verify completion.
- 3.11. COMMISSIONING AGENT
- 3.11.1. A Commissioning Agent will be hired by the Owner.
- 3.11.2. The Commissioning Agent responsibilities shall include:
- .1 Preparing the commissioning plan
 - .2 Co-ordinating with the Contractor to schedule tests
 - .3 Preparing a test form manual
 - .4 Witnessing selected tests
 - .5 Receiving all test forms

- .6 Conducting performance test
- .7 Co-ordinating the Contractor's training
- .8 Attending commissioning meetings
- .9 Preparing the systems operating manuals (as required)
- 3.11.3. Co-ordinate and co-operate with the Commissioning Agent.
- 3.12. PERFORMANCE TESTING
- 3.12.1. The Commissioning Agent will conduct performance tests on each mechanical system to verify that the design intent performance has been met. The performance tests will cover all seasonal modes. The Commissioning Agent will visit the building in six months to retest the systems.
- 3.12.2. The Contractor shall conduct performance tests on all mechanical systems and document the results on the performance forms.
- 3.12.3. The Contractor shall provide assistance to the Commissioning Agent and have personnel available during the performance testing procedures during construction and the warranty period.
- 3.12.4. Performance testing will begin when all mechanical systems have been completed, tested by the Contractor, reviewed by the Engineer's Representative and Substantial Performance has been achieved.
- 3.13. COMMISSIONING PROCESS ALLOCATION
- 3.13.1. The commissioning process shall be allocated a value equal to 8% of the Contract. This value shall be itemized in the Statement of Prices which forms the basis for progress payments for the various portions of Work. The Contractors may draw from this allocation as the commissioning process is completed.
 - .1 The Contractors shall submit all test and verification forms. The Engineer's Representative will use these forms to calculate a percentage complete.
 - .2 The Contractor may claim up to 5% of the Contract, as per Schedule of Breakdown, on a monthly basis, from this allocation leading up to performance testing. The remaining 3% shall not be paid out until the performance testing, O&M manuals and training have been completed satisfactorily.
- 3.13.2. Break down the commissioning process allocation as follows:

Shop Drawings	0.50%
Installation review and equipment verification	0.50%
Plumbing and drainage system testing	0.50%
Testing of piping systems	0.50%
Contractor balancing of piping systems	0.25%
Testing of air systems	0.50%
Contractor balancing of air systems	0.25%
Testing of equipment and systems (system start-up)	0.50%
BAS commissioning	1.00%
Commissioning Agent Performance Testing	2.00%
Operating and Maintenance Manuals	0.50%

Training	0.50%
As-built drawings	0.50%

END OF SECTION

20 08 02.00 Cleaning and Protection

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. NOT USED

3. Execution

3.1. INSTALLATION

3.1.1. Clean thoroughly all fixtures and equipment from grease, dirt, plaster or any other foreign material. Chrome-plated fittings, piping and trim shall be polished upon completion.

3.1.2. Fixtures and equipment shall be properly protected from damage during the construction period and shall be cleaned and polished in accordance with manufacturer's written directions. Motors and equipment bearings shall be protected with plastic sheets, tied or taped in place. Aluminum fin heating or cooling elements shall be protected with cardboard covers.

3.1.3. Any dirt, rubbish, or grease on walls, floors or fixtures accumulated from the Work of the Mechanical Division shall be removed promptly from the premises by this Division.

3.1.4. Any unpainted steel surfaces, installed for longer than one year prior to the completion date, shall be prime coated under this Division.

3.1.5. During construction protect all services and equipment from dirt and debris, by using temporary caps over the open ends of pipes ductwork and equipment connections.

3.1.6. All equipment installed or stored on site shall be maintained in accordance with manufacturer's recommended instructions (i.e. rotate shafts on fans, pumps, etc.).

3.1.7. Refinish and restore to the original condition and appearance all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and work quality shall be equal to the manufacturer's original.

END OF SECTION

20 08 03.00 Operating and Maintenance Instructions

1. General

1.1. WORK INCLUDED

- 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2. Comply with all requirements of Section 20 05 02.00 - AS-BUILT DRAWINGS.
- 1.1.3. Comply with all requirements of Section 20 05 03.00 - SHOP DRAWINGS.
- 1.1.4. Comply with all requirements of Section 20 08 00.00 - COMMISSIONING.
- 1.1.5. Comply with all requirements of Section 01 78 00 - CLOSEOUT SUBMITTALS.

2. Products

2.1. REQUIREMENTS FOR MANUALS

- 2.1.1. Three copies of complete and approved operating and maintenance instructions for all mechanical equipment and systems shall be supplied before Substantial Completion. Manuals shall be also submitted in electronic format. Electronic manuals shall be prepared in Adobe PDF format with all sections bookmarked for quick reference and submitted on a portable data storage device.
- 2.1.2. Binders shall be three-ring, hard-cover, loose-leaf type and identified on the binding edges as "Maintenance Instructions and Data Book", for "(Project Name)".
- 2.1.3. Terminology used in all the Sections shall be consistent.
- 2.1.4. Include the data and requirements noted in this specification section in both hardcopy and electronic versions of all manuals. Divide pages in the hardcopy manuals by tabs and sub-tabs as per the clauses and sub-clauses below. Provide only searchable PDF files as part of electronic version of the manuals and divide PDF document(s) using section cover pages and PDF bookmarks as per the clauses and sub-clauses below.
- 2.1.5. Volume One shall contain the master index of all systems, the name of the Contractor, Mechanical Subcontractors and the date of Substantial Performance of the Work.
- 2.1.6. Volume One shall contain a section with all necessary warranty information.
- 2.1.7. Each binder shall have a complete index for all volumes.
- 2.1.8. Each binder shall be no more than half filled.
- 2.1.9. There shall be a separate section for all materials used on the Project which fall under the WHMIS legislation. There shall be a hazard data sheet for each of the materials.
- 2.1.10. There shall be a separate section for all Insurance Certificates, Test Certificates, Verification Forms and Test Forms.
- 2.1.11. All relevant information relating to a system or Product shall be contained within one binder.
- 2.1.12. The manual sections shall follow the Specification sections.
- 2.1.13. Any diagrams, installation drawings, flow charts, etc. shall be mechanically reduced while maintaining full legibility to standard page size. If this cannot be achieved they shall be carefully folded and contained within a clear plastic wallet within the manual.

2.2. DATA FOR MANUALS

2.2.1. Equipment data shall contain:

- .1 Operating instructions
- .2 Operating conditions such as temperature and pressure
- .3 Location of equipment
- .4 Maintenance instructions and schedules for one year routine
- .5 Recommended list of spare parts
- .6 Lubrication schedule
- .7 A trouble shooting table showing where to look for problems under various conditions of malfunction
- .8 All wiring diagrams
- .9 Equipment operating curves
- .10 Equipment nameplate data and serial numbers

2.2.2. System data shall contain:

- .1 A listing of all systems
- .2 A valve schedule and locations
- .3 Equipment name tags
- .4 Filter schedule
- .5 An electric pipe tracing schedule including location and electrical service location
- .6 Cleaning, maintaining and preserving instructions for all material, Products and surfaces. Include warnings of harmful cleaning, maintaining and preserving practices.

2.2.3. Subcontractor manuals are required for:

- .1 BAS
- .2 Water treatment
- .3 Sprinkler system
- .4 Piping and air balancing

2.2.4. As-built documentation shall contain:

- .1 Reviewed As-built Shop Drawings
- .2 As-built construction drawings
- .3 Originals of test forms
- .4 Originals of test certificates
- .5 Cyber Security Report Letter and backup schedule as required by Section 20 05 00.00
– GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2.3. OPERATING INSTRUCTIONS

2.3.1. Instruct the Owner's representative in all aspects of the operation and maintenance of systems and equipment.

2.3.2. Comply with all requirements of Section 20 08 00.00 - COMMISSIONING, for duration of tests.

2.3.3. Instruct the Owner for a minimum of five (5) Working Days.

2.3.4. Arrange for and pay for the services of engineers and other manufacturer's representatives required for instruction on the systems and the equipment as requested by the Engineer's Representative and/or the Owner.

- 2.3.5. At the time of final review, provide a sheet for each system and piece of equipment showing the date instructions were given. Each sheet shall show the duration of instruction, name of persons receiving instruction, other persons present (manufacturer's representative, Engineer's Representative, etc.), system or equipment involved and signature of the Owner's staff stating that they understood the system installation, operating and maintenance requirements. This information shall be inserted in the manuals after all instructions have been completed.
- 2.3.6. Review information with the Owner's representative to ensure that all information required has been provided.
- 2.3.7. Mechanical equipment and systems included in the instruction requirements are:
- .1 Chillers and associated equipment
 - .2 Heating water generators and associated equipment
 - .3 Automatic controls and instrumentation
 - .4 Water treatment and cleaning
 - .5 Life safety and fire protection
 - .6 Noise and vibration
 - .7 Condenser water distribution system
 - .8 Chilled water distribution systems
 - .9 Heating water distribution systems
 - .10 Air handling distribution and components
 - .11 Miscellaneous ventilation systems
 - .12 Humidification systems
 - .13 Storm, sanitary and domestic water pumping and distribution system
- 2.4. TRIAL USAGE
- 2.4.1. The Owner shall be permitted trial usage of systems or parts of systems for the purpose of testing and learning operational procedures. Trial usage shall not affect the warranties nor be construed as acceptance, and no claim for damage shall be made against the Owner for any injury or breakage to any part or parts due to the tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or work quality of any kind.
3. Execution
- 3.1. NOT USED
- END OF SECTION

22 05 33.00 Electric Tracing for Domestic Hot Water

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.1.2. Conform to Section 26 05 01.00 - GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - 1.2. SUBMITTALS
 - 1.2.1. Submit Shop Drawings of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.
 - 1.3. WARRANTY
 - 1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Electric tracing for Domestic Hot Water nVent Raychem HWAT self-regulating (ranges 40.5 deg. C. (105 deg. F.), 46 deg. C. (115 deg. F.), 52 deg. C. (125 deg. F.), 60 deg. C. (140 deg. F.)) with minimum 40 year life rating for 208 volt, 1 phase supply.
 - 2.1.2. Tracing cable shall be self regulating type.
 - 2.1.3. Contactors if required shall be Allen Bradley 702L Series with 120 volt coil and pilot light in cover. Provide control transformer as required.
3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Cable shall cover the pipe for the full length shown with no gaps. Particular care shall be taken to ensure that valve body and bonnet are completely protected.
 - 3.1.2. Heating cable shall be installed after pipe installation and testing is complete. Attach cable as recommended by the manufacturer with pipe straps.
 - 3.1.3. The entire installation shall be inspected and approved by the manufacturer before the pipe is concealed and/or insulated. Check for breaks with a 2500 volt meter. Provide report as a submittal for Engineer's review and include final reviewed copy in the operating manuals. The cost of inspection shall be included in the Contract Price.
 - 3.1.4. The installation by this section shall be complete requiring power supply only by the electrical division. Provide all wiring between the electric tracing and the electrical junction box and make final connections.

END OF SECTION

22 05 76.00 Cleanouts

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.2. FINISHED AREAS

2.2.1. Cleanouts in finished areas with membrane floors shall be coated cast iron body with adjustable nickel bronze frame and round scoriated gas tight access cover with secondary gas tight plug. Jay R. Smith 4020-F-C, Zurn ZN 1400-KC, Mifab C1100C-R-1-34, Watts CO-100-C-R-1-34G.

2.2.2. Cleanouts with recess for terrazzo shall be similar to cleanouts in finished areas with membrane floors but shall have terrazzo recess. Jay R. Smith 4180-F-C, Zurn ZN 1400-Z-KC, Mifab C1100C-UR-1-34, Watts CO-100-C-R-1-34G.

2.2.3. Cleanouts with recess for tile shall be similar to cleanouts in finished areas with membrane floors but shall have 3 mm (1/8 in.) tile recess. Jay R. Smith 4140-F-C, Zurn ZN 1400-X-KC, Mifab C1100C-T-1-34, Watts CO-100-C-R-1-34G.

2.2.4. Cleanouts for carpeted areas shall be similar to cleanouts in finished areas but shall have stamped stainless steel carpet marker. Jay R. Smith 4020-Y, Zurn ZN 1400-CM, Mifab C1100-RC-1-34, Watts CO-100-C-R-1-34G.

2.3. NON-FINISHED AREAS

2.3.1. Cleanouts in non-finished areas shall be all coated cast iron body with heavy duty cast iron or ductile iron top. Jay R. Smith 4220-F-C, Zurn Z-1400-KC, Mifab C1100-XR-4-34, Watts CO-100-C-R-1-34G.

2.3.2. Cleanouts at the base of each vertical stack and rain water leader shall be either Daisy or Barrett type.

3. Execution

3.1. INSTALLATION

- 3.1.1. Cleanouts in furred ceiling spaces shall extend up through floor slab above, except where the Engineer's Representative gives specific approval to its location in the ceiling space.
- 3.1.2. Cleanouts shall be installed in horizontal drains at each change of direction and as required.

END OF SECTION

22 05 79.00 Service Connections

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Arrange and pay for all service connections.

1.1.3. Include the cost of all service connections required for the gas, plumbing and drainage systems, including water meter, in the mechanical bid price.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. NOT USED

3. Execution

3.1. NOT USED

END OF SECTION

22 11 13.00 Pipes, Valves and Fittings (Plumbing System)

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Unless where indicated otherwise, provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Pipes and fittings shall be in accordance with the following unless specified otherwise by local authorities.

2.1.2. All valves on potable water systems shall be equal in performance to the models specified, shall be lead free or low lead meeting the requirements of CSA B125.3 "Plumbing fittings," CSA B125.14 "Manually operated valves for use in plumbing systems," NSF/ANSI 372 "Drinking Water System Components - Lead Content," NSF/ANSI 61 "Drinking Water System Components - Health Effects," NSF/ANSI 14 "Plastics Piping System Components and Related Materials," and/or ANSI/AWWA C550 "Protective Interior Coatings for Valves and Hydrants" as applicable.

2.1.3. All city and domestic water, above ground, 75 mm (3 in.) and smaller, less than 1380 kPa (200 psi) working pressure:

- .1 Pipe: Copper Tubing, Type "L", Hard Drawn, ASTM B88 "Standard Specification for Seamless Copper Water Tube." Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 "Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings" or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18 "Cast Copper Alloy Solder Joint Pressure Fittings."
- .2 Joints made with 95-5 tin antimony, 96-6 tin silver, or 96-4 tin silver solder, ASTM B32 "Standard Specification for Solder Metal."
- .3 Grooved end copper fittings designed to accept grooved end couplings of the same manufacturer. Fittings shall be wrought copper or bronze casting, conforming to ASTM B75/B75M "Standard Specification for Seamless Copper Tube." Victaulic Copper Connection Fittings.
- .6 Couplings to be designed with angle bolt pads to provide a rigid joint.
 - .1 Installation ready for direct stab installation without field disassembly, complete with grade P fluoroelastomer gasket, rated for -18 deg. C. to 82 deg. C. (0 deg. F. to 180 deg. F.). Victaulic 607.

- .7 Stainless steel pipe may be used as an alternative material if acceptable to Local Authorities. Follow applicable codes for stainless steel pipe joints. Stainless steel pipe to conform to ASTM A312 "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes." Stainless steel fittings to conform to ASTM A403 "Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings."
 - .1 Schedule 10 Type 304/304L to ASTM A312.
 - .8 Butterfly valves, bubble-tight service up to 2065 kPa (300 psi) with cast brass bronze body, aluminum-bronze disc, pressure-responsive grade P fluoroelastomer seat, and stainless steel stem. Victaulic 608N.
 - .9 Gate valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with lead free bronze body, rising stem screwed. Kitz 827/828, Toyo 206A-LF/207A-LF, Apollo 101T-LF.
 - .10 Globe valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with lead free bronze body, solder ends or with screwed to solder adapter and composition disc for water service. Kitz 811/812, Toyo 211A-LF/212A-LF, Apollo 120S-LF.
 - .11 Check valves 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with lead free bronze body, swing check, solder ends. Kitz 822/823, Toyo 236A-LF/237A-LF, Apollo 161S-LF.
 - .12 Non-slam check valves downstream from pumps, ANSI Class 150, 1032 kPa (150 psi) WSP pressure rating, dual flapper design with 316 stainless steel body and stainless steel check, renewable disc and resilient seat for flanged installation. Non-slam check valves shall be Velan-ProQuip Model DDD11-1D, Duo CHEK II H15CMF3-14, Mueller 72-HHH-3-H, or NCI/SSI 150WTTTV-T.
 - .13 Strainers shall be lead free bronze Y body equal to Mueller LF351.
 - .14 Drain valves and blow-off valves shall be 4137 kPa (600 psi) WG 19 mm (3/4 in.) ball valves with lead free, bronze body or forged brass body, solid ball, male threaded garden hose end, brass cap and chain equal to Watts B6000, Toyo 5046-LF, Kitz 868C or Apollo 78-100. Hose bibbs shall be for 860 kPa (125 psi) non-shock, bronze body with composition disc and 19 mm (3/4 in.) garden hose thread, complete with a ULC vacuum breaker.
 - .15 Pipe sizes 12 mm (1/2 in.) to 50 mm (2 in.) Schedule 10 Type 304/304L to ASTM A312/A312M "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes."
 - .1 Vic-Press 304 ASTM A312 stainless steel housings with ASTM A276 "Standard Specification for Stainless Steel Bars and Shapes" and A312 outlets and austenitic stainless steel plain or grooved ends, type 304, complete with synthetic rubber Grade "H" (HNBR) seals rated for applicable services to 82 deg. C (180 deg. F).
- 2.1.4. All city and domestic water above ground 100 mm (4 in.) and larger, less than 1380 kPa (200 psi) working pressure.
- .1 Pipe: Copper Tubing, Type "L", Hard Drawn, ASTM B88 "Standard Specification for Seamless Copper Water Tube." Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 "Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings" or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18 "Cast Copper Alloy Solder Joint Pressure Fittings."
 - .2 Domestic Cold Pipe: Copper Tubing, Type "L", Hard Drawn, ASTM B88 "Standard Specification for Seamless Copper Water Tube." Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 "Wrought Copper and Copper Alloy Solder-Joint

- Pressure Fittings” or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18 “Cast Copper Alloy Solder Joint Pressure Fittings.”
- .3 Domestic Hot and Recirculation Pipe: Copper Tubing, Type “K”, Hard Drawn, ASTM B88 “Standard Specification for Seamless Copper Water Tube.” Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 “Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings” or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18 “Cast Copper Alloy Solder Joint Pressure Fittings.”
 - .4 Joints made with 96-6 tin silver, or 96-4 tin silver solder, ASTM B32 “Standard Specification for Solder Metal.”
 - .5 Grooved end copper fittings designed to accept grooved end couplings of the same manufacturer. Fittings shall be wrought copper or bronze casting, conforming to ASTM B75/B75M “Standard Specification for Seamless Copper Tube.” Victaulic Copper Connection Fittings.
 - .8 Couplings to be designed with angle bolt pads to provide a rigid joint.
 - .1 Installation ready for direct stab installation without field disassembly, complete with grade P fluoroelastomer gasket, rated for -18 deg. C. to 82 deg. C. (0 deg. F. to 180 deg. F). Victaulic 607.
 - .9 Butterfly valves, bubble-tight service up to 2065 kPa (300 psi), with cast brass bronze body, aluminum-bronze disc, pressure-responsive grade P fluoroelastomer seat, and stainless steel stem.. Victaulic 608N.
 - .10 Stainless steel pipe may be used as an alternative material if acceptable to Local Authorities. Follow applicable codes for stainless steel pipe joints. Stainless steel pipe to conform to ASTM A312 “Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.” Stainless steel fittings to conform to ASTM A403 “Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.” Schedule 10 Type 304/304L to ASTM A312.
 - .1 Rigid type: Couplings to be designed with angle bolt pads to provide a rigid joint. Installation ready for direct stab installation without field disassembly, complete with grade P fluoroelastomer gasket, rated for -18 deg. C. to 82 deg. C. (0 deg. F. to 180 deg. F). Victaulic 807N.
 - .2 Flexible Type: For use in locations where vibration attenuation and stress relief are required or in a Victaulic riser design. Three flexible couplings may be used in lieu of a flexible connector. Flexible grooved couplings may be used where system flexibility is desired. Installation ready for direct stab installation without field disassembly, complete with grade P fluoroelastomer gasket, rated for -18 deg. C. to 82 deg. C. (0 deg. F. to 180 deg. F). Victaulic Style 877N.
 - .3 Butterfly valves, bubble-tight service up to 2065 kPa (300 psi), with stainless steel body, grade P fluoroelastomer seat. Victaulic 861.
 - .4 Check valves, Stainless steel body, grade P fluoroelastomer seat, stainless steel disc with spring loaded design for non slam operation. Victaulic Series 816.
 - .11 Gate valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with ANSI/AWWA C550 “Protective Interior Coatings for Valves and Hydrants” coated iron body, lead free bronze mounted, outside screw and yoke, and flanged ends.
 - .12 Globe valves, 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock ANSI/AWWA C550 “Protective Interior Coatings for Valves and Hydrants” coated iron body, lead free bronze mounted, outside screw and yoke, flanged ends and composition disc for water service.
 - .13 Check valves 860 kPa (125 psi) WSP or 1380 kPa (200 psi) non-shock WOG with ANSI/AWWA C550 “Protective Interior Coatings for Valves and Hydrants” coated iron body, lead free bronze mounted, swing check, flanged ends.

- .14 Non-slam check valves downstream from pumps, 1032 kPa (150 psi) pressure rating, dual flapper design with 316 stainless steel body and stainless steel check, renewable disc and resilient seat for flanged installation. Non-slam check valves shall be Velan-ProQuip Model DDD11-1D1, Duo CHEK II H15CMF3-14, Mueller Sure Check #72-HHH-3-H, or NCI/SSI 150WTTTV-T.
 - .15 Strainers shall be lead free grooved or flanged ANSI/AWWA C550 "Protective Interior Coatings for Valves and Hydrants" coated cast iron Y body equal to Victaulic 968-F or Mueller #758.
 - .16 Drain valves and blow-off valves shall be 4137 kPa (600 psi) WG 19 mm (3/4 in.) ball valves with lead free, bronze or forged brass body, solid ball, virgin Teflon seat and packing, male threaded hose end, brass cap and chain equal to Watts B6000, Toyo 5046, Kitz 58CC or Apollo 78-100.
- 2.1.5. All domestic water above ground 75 mm (3 in.) and smaller, over 1380 kPa (200 psi) working pressure and under 2070 kPa (300 psi) working pressure:
- .1 Pipe: Copper Tubing, Type "L", Hard Drawn, ASTM B88 "Standard Specification for Seamless Copper Water Tube."
 - .2 Joints, brazed.
 - .3 Grooved end copper fittings designed to accept grooved end couplings of the same manufacturer. Fittings shall be wrought copper or bronze casting, conforming to ASTM B75/B75M "Standard Specification for Seamless Copper Tube." Victaulic Copper Connection Fittings.
 - .4 Couplings to be designed with angle bolt pads to provide a rigid joint.
 - .1 Installation ready for direct stab installation without field disassembly, complete with grade P fluoroelastomer gasket, rated for -18 deg. C. to 82 deg. C. (0 deg. F. to 180 deg. F). Victaulic 607.
 - .5 Stainless steel pipe is an acceptable alternative where accepted by authorities having jurisdiction. Follow applicable codes for stainless steel pipe joints. Stainless steel pipe to conform to ASTM A312 "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes." Stainless steel fittings to conform to ASTM A403 "Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings."
 - .6 Butterfly valves, bubble-tight service up to 2065 kPa (300 psi) with cast brass bronze body, aluminum-bronze disc, pressure-responsive grade P fluoroelastomer seat, and stainless steel stem. Victaulic 608N.
 - .7 Gate valves, 1035 kPa (150 psi) WSP or 2070 kPa (300 psi) non-shock WOG, lead free bronze body solder ends or screwed to solder adapter. Kitz 827/828, Toyo 206A-LF/207A-LF.
 - .8 Globe valves, 1035 kPa (150 psi) WSP or 2070 kPa (300 psi) non-shock WOG, lead free bronze body solder ends or screwed to solder adapter, composition disc. Kitz 811/812, Toyo 211A-LF/212A-LF, Apollo 120S-LF.
 - .9 Check valves, 1380 kPa (200 psi) WSP or 2760 kPa (400 psi) non-shock WOG, lead free bronze body swing check, solder or screwed ends to solder adapters. Kitz 822/823, Toyo 236A-LF/237A-LF, Apollo 161S-LF.
 - .10 Non-slam check valves downstream from pumps, dual flapper design with stainless steel body, check, renewable disc and resilient seat for flanged installation equal to Velan Proquip 2070 kPa (300 psi) pressure rating model 4DD111, Duo CHEK II S-3 G30CPF 559, Mueller Sure Check #74-HHH-6-H, or NCI/SSI 150WTTTV-T.
 - .11 Strainers shall be lead free bronze Y body equal to Mueller LF352.

- .12 Drain valves and blow-off valves shall be 4137 kPa (600 psi) WG 19 mm (3/4 in.) ball valves with bronze or forged lead free brass body, solid ball, virgin Teflon seat and packing, male threaded hose end, cap and chain. Equivalent to Watts B6000, Toyo 5046-LF, Kitz 868C or Apollo 78-100.
- .13 Pipe sizes 12 mm (1/2 in.) to 50 mm (2 in.) Schedule 10 Type 304/304L to ASTM A312/A312M "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes."
 - .1 Vic-Press 304 ASTM A312 stainless steel housings with ASTM A276 "Standard Specification for Stainless Steel Bars and Shapes" and A312 outlets and austenitic stainless steel plain or grooved ends, type 304, complete with synthetic rubber Grade "H" (HNBR) seals rated for applicable services to 82 deg. C (180 deg. F).
- 2.1.6. All domestic water 100 mm (4 in.) and larger, over 1380 kPa (200 psi) working pressure and under 3440 kPa (500 psi) working pressure:
 - .1 Pipe: Copper Tubing, Type "L", Hard Drawn, ASTM B88 "Standard Specification for Seamless Copper Water Tube." Fittings: wrought copper solder joint pressure fittings, ANSI/ASME B16.22 "Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings" or cast copper alloy solder joint pressure fittings, ANSI/ASME B16.18 "Cast Copper Alloy Solder Joint Pressure Fittings."
 - .2 Joints, brazed.
 - .3 Stainless steel pipe is an acceptable alternative on sizes 100 mm (4 in.) and over where accepted by authorities having jurisdiction. Follow applicable codes for stainless steel pipe joints. Stainless steel pipe to conform to ASTM A312 "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes." Stainless steel fittings to conform to ASTM A403 "Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings."
 - .4 Gate valves, 1730 kPa (250 psi) WSP or 3440 kPa (500 psi) WOG non-shock, NSF/AWWA coated cast steel, half stelite, outside screw and yoke, flanged ends.
 - .5 Globe valves, 1730 kPa (250 psi) WSP or 3440 kPa (500 psi) WOG non-shock, NSF/AWWA coated iron body, lead free bronze mounted, outside screw and yoke, flanged ends, stainless steel seat and disc.
 - .6 Check valves, 1720 kPa (250 psi) WSP or 3440 kPa (500 psi) WOG, NSF/AWWA coated iron body lead free bronze mounted, swing check, flanged ends.
 - .7 Non-slam check valves downstream of pumps dual flapper design with stainless steel body, check, renewable disc and resilient seat for flanged installation equal to Velan Proquip 2069 kPa (300 psi) pressure rating Model 4DD111, DUO CHEK II, Mueller Sure Check 74-HHH-3-H, or NCI/SSI 150WTTTV-T.
 - .8 Strainers shall be extra heavy flanged cast iron Y body equal to Mueller #752.
 - .9 Drain valves and blow-off valves shall be 4137 kPa (600 psi) WOG, 19 mm (3/4 in.) ball valves with bronze or forged brass body, solid ball, virgin Teflon seat and packing, male threaded hose end, cap and chain. Equivalent to Watts B6000, Toyo 5046, Kitz 58CC or Apollo 78-100.
- 2.1.7. All city and domestic water, buried, 50 mm (2 in.) and smaller:
 - .1 Soft copper Type K conforming to ASTM B88 "Standard Specification for Seamless Copper Water Tube."
 - .2 Minimum number of joints brazed using BCuP-3 alloy with 5% silver, 89% copper, and 6% phosphorus.
 - .3 Gate valves, bronze body, non-rising stem, extension sleeve and box to grade, to local authorities' approval.

- 2.1.8. All city and domestic water, buried, 65 mm (2-1/2 in.) and larger:
- .1 Copper pipes Type L with wrought or cast couplings and fittings conforming to ASTM B88 "Standard Specification for Seamless Copper Water Tube," etc.
 - .2 Joints brazed using BCuP-3 alloy with 5 % silver, 89 % copper, and 6 % phosphorus.
 - .3 Alternate for underground pipe; cast or ductile iron coated to AWWA.
 - .4 Gate valves, AWWA iron body, non-rising stem, extension sleeve and box to grade, to local authorities' approval.
- 2.1.9. For storm and sanitary drains and vents above ground, provide cast iron or copper pipe installed as in regulations; except where copper pipe is used, make joints with 95-5 solder. ABS and asbestos cement (Transite) pipes are not acceptable.
- .1 For cast iron pipe fittings on sanitary and storm, provide fittings equal to Bibby-Ste-Croix Husky SD 4000 heavy duty fittings in the following areas:
 - .1 Between P1 and XXXX Floor.
 - .2 All vertical to horizontal pipe connections.
 - .3 All joints in the Lobby and other amenity areas.
 - .4 Horizontal to horizontal connections within 3 m of the vertical to horizontal connection.
 - .2 For cast iron pipe fittings on vents, provide fittings equal to Bibby-Ste-Croix Husky SD 4000 heavy duty fittings in the following areas:
 - .1 Horizontal offsets between the roof penetration and the normally vertical vent stack where vents penetrate sloped roofs.
 - .2 The first two (2) couplings or fittings below the roof penetration where vents penetrate sloped roofs.
 - .3 Do not provide unshielded couplings.
- 2.1.10. Storm and sanitary drains and vents, not buried, inside the building, to CSA B1800 "Thermoplastic nonpressure piping compendium":
- .1 Provide PVC DWV pipe and fittings manufactured by IPEX or engineer reviewed equivalent. Provide Products from one manufacturer throughout the Project.
 - .2 For retail spaces: IPEX System XFR PVC DWV Schedule 40 pipe and fittings, meeting flame-spread rating not more than 25, and smoke developed classification not more than 50, both per CAN/ULC-S102.2, with pipe manufacturer's approved solvent weld joints or pipe manufacturer's approved mechanical joint couplings. Do not provide unshielded mechanical joint couplings.
 - .3 For Buildings that are not classified as High Buildings, except for retail spaces: IPEX System 15 PVC DWV Schedule 40 pipe and fittings, meeting flame-spread rating not more than 25, per CAN/ULC-S102.2 "Standard Method of Testing for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies," with pipe manufacturer's approved solvent weld joints or pipe manufacturer's approved mechanical joint couplings. Do not provide unshielded mechanical joint couplings.
 - .4 For High Buildings or for inside air plenums: IPEX System XFR PVC DWV Schedule 40 pipe and fittings, meeting flame-spread rating not more than 25, and smoke developed classification not more than 50, both per CAN/ULC-S102.2, with pipe manufacturer's approved solvent weld joints or pipe manufacturer's approved mechanical joint couplings. Do not provide unshielded mechanical joint couplings.
- 2.1.11. Where localized spill containment is required for liquid filled transformers, provide welded Schedule 40 steel piping from the floor drain to the oil sump.

- .1 Provide Fernco Flexible Chemical Coupling between drain and piping system, rated for a maximum temperature as follows:
 - .1 100 deg. C (212 deg. F) consistent
 - .2 130 deg. C (266 deg. F) intermittent
- 2.1.12. Vent stack covers:
 - .1 1100-0T alloy aluminum with vandal proof removable cap
 - .2 EPDM base seal
 - .3 PVC coated deck flange or bituminous deck flange as required to suit roof membrane
 - .4 Insulated for inverted steel roof construction with insulation on top of deck
 - .5 Uninsulated for concrete roof construction
 - .6 Uninsulated: Thaler Metal Industries SJ-34/SJ-35/SJ-36
 - .7 Insulated: Thaler Metal Industries SJ-37/SJ-38/SJ-39
- 2.1.13. Buried storm and sanitary inside the building shall be Class 4000 grey cast iron soil pipe, black bituminous coating, fittings and means of joining to meet the requirements of CSA B70 "Cast iron soil pipe, fittings, and means of joining." Mechanical couplings for drain, waste, vent pipe and sewer pipe to meet the requirements of CSA B602 "Mechanical couplings for drain, waste, and vent pipe and sewer pipe." Bituminous fibre, vitrified clay, ABS and PVC pipe are not acceptable.
- 2.1.14. Buried storm and sanitary inside the building shall be SDR 28 rigid for 100 mm (4 in.) to 150 mm (6 in.), SDR 35 for 200 mm (8 in.) and larger, green PVC gasketed hub and spigot pattern sewer pipe and injection molded and fabricated gasketed fittings to meet the requirements of CSA B182.2 "PSM type polyvinylchloride (PVC) sewer pipe and fittings" assembled with PVC pipe lubricant.
- 2.1.15. Buried storm and sanitary, inside the building: PVC DWV Schedule 40 to CSA B1800 "Thermoplastic nonpressure piping compendium."
- 2.1.16. All embedded pipe and materials in parking structures and ramps shall meet the requirements of CSA S413 "Parking Structures" for corrosion resistant materials or shall have a corrosion resistant coating.
- 2.1.17. Sump and sewage pump discharge, non potable, buried:
 - .1 Type "L" copper, brazed; or
 - .2 Schedule 80 PVC pressure piping conforming to CSA B137.3 "Rigid polyvinylchloride (PVC) pipe and fittings for pressure applications."
- 2.1.18. Butterfly valves may be used in lieu of gate valves in size 65 mm (2-1/2 in.) and over in systems 1380 kPa (200 psi) and less. Where specifically shown on Drawings, butterfly valves must be used. Install between 860 kPa (125 psi) flanges.
 - .1 Valves shall have NSF/AWWA coated iron body, one piece or split alloy steel shaft, top and bottom bearings, lead free bronze disc or coated iron disc with stainless steel trim and resilient elastomer replaceable seat with integral reinforcing ring or keyed to body.
 - .2 Body shall have threaded lugs.
 - .3 Valve shall have bubble tight shut-off to 1035 kPa (150 psi) pressure in either direction when the piping and connecting flange is removed from one side of the valve.
 - .4 Valves 100 mm (4 in.) and smaller shall have lever operator with lock.
 - .5 Valves larger than 100 mm (4 in.) shall have worm gear manual operator with indication of valve opening.

- .6 Butterfly valves for grooved end systems shall be Victaulic 608N for copper and Victaulic 861 for stainless steel.
- 2.1.19. Backflow Preventers – Reduced Pressure Back Flow Preventer:
 - .1 Reduced pressure zone assemblies to prevent the reverse flow of polluted water from entering into the potable water supply due to back-siphonage and or backpressure.
 - .2 Lead Free bronze body construction (1/4 to 2 in.).
 - .3 Lead Free epoxy coated ductile or cast iron (2 1/2 to 10 in.).
 - .4 Two, in-line independent check valves, replaceable check seats with an intermediate relief valve, and ball valve test cocks.
 - .5 Maximum Working Pressure: 1207 kPa (175 psi).
 - .6 BEECO FRP, Zurn-Wilkins 975XL2/375A or Watts LF009/LF909 Series.
- 2.1.20. Ball valves 50 mm (2 in.) and smaller shall be lead free, bronze body or forged brass 4137 kPa (600 psi) WOG, virgin Teflon seat, TFE stem packing and thrust washer, 1/4 turn open-closed operation with solid ball. Ball valves shall be Watts No. LFB-6000, Toyo 5044A-LF/5049A-LF, Kitz 858/859, Apollo 70LF-100/200, or NCI 600FP-T/S. Stem extensions shall be provided on all ball valves. Ball valves may be substituted for gate valves only.
- 2.1.21. Except where special features are required or unless otherwise approved or noted, all valves shall be of one manufacturer with the manufacturer's name and the pressure rating clearly marked on the outside of the valve body.
- 2.1.22. Pressure Reducing Valves:
 - .1 For all sizes of grooved piping, provide pressure reducing valves equal to Victaulic Series 386-SB single branch pressure reducing valve stations with integral low flow bypass. For single stage pressure reducing valves, provide valves equal to Victaulic 386A-SB. For two stage pressure reducing valve stations, provide valves equal to Victaulic 386B-SB. Provide valves at capacity shown in PRV Schedule and with a pressure drop not exceeding 69 kPa (10 psi) under full flow. Provide valves that maintain downstream pressure within a range of plus or minus 35 kPa (5 psi). Provide required outlet pressure, inlet pressure, and flow rate as shown. Alternate manufacturers will not be accepted.
 - .1 Provide pressure reducing station that is complete with inlet and outlet isolation valve, strainer, and pressure reducing valve with integral low flow by-pass.
 - .2 For 65 mm (2-1/2 in.) and larger, non grooved, provide Cla-Val 90-01 or equal with capacity shown and a pressure drop not exceeding 69 kPa (10 psi) under full flow. Provide valve that maintains downstream pressure within a range of plus or minus 35 kPa (5 psi). Provide required outlet pressure, inlet pressure and flow rate as shown. Alternate manufacturers will not be accepted.
 - .1 Provide valve that maintains a constant downstream pressure regardless of fluctuations in demand and that also prevents a pressure rise when demand is zero.
 - .2 Provide valve that is single-seated, hydraulically operated, pilot controlled diaphragm type globe valve. Provide valve stem that is top and bottom guided and actuated by a resilient diaphragm. Provide cast iron, flanged valve body and cover. Provide bronze trim. Provide replaceable valve seat. Do not provide external packing glands. Provide valve that is NSF/ANSI 61 "Drinking Water System Components - Health Effects" and NSF/ANSI 372 "Drinking Water System Components - Lead Content" compliant.
 - .3 Provide pilot control that is a direct acting, adjustable, spring-loaded valve with bronze body and stainless steel trim.

- .4 Factory assemble main valve, pilot control valve, and all trim into one unit.
- .5 Provide valve that is Class 125 for low pressure systems less than 1380 kPa (200 psi) working pressure and Class 250 for high pressure systems greater than 1380 kPa (200 psi) working pressure.
- .6 See Drawing for capacities and operating pressures.
- .7 For isolation valves, provide full port ball valves for 64 mm (2-1/2 in.) and smaller and butterfly valves for 76 mm (3 in.) and larger.
- .8 For combination pressure reducing and check valve, provide Cla-Val 90-01-D and as specified for the pressure reducing valve, but with a check valve and isolation valve.
- .3 50 mm (2 in.) and smaller: Threaded lead free water pressure reducing valve and integral strainer, suitable for 2068 kPa (300 psi) incoming pressure with downstream pressure adjustable range from 172 to 517 kPa (25 psi to 75 psi). Provide thermal expansion by-pass check valve that allows water to flow back to main when the downstream pressure exceeds setpoint.
 - .1 Materials:
 - .1 Lead free copper silicon alloy body
 - .2 Sealed spring cage with stainless steel fasteners
 - .3 High temperature reinforced diaphragm
 - .4 Replaceable seat
 - .5 Stainless steel strainer
 - .2 Acceptable Manufacturers:
 - .1 Watts LFU5B-Z3 Cash Acme E3 See Drawings for capacities and operating pressures.
- 2.1.23. Backwater valves for services larger than 100 mm (4 in.) shall be by Jay R. Smith. Valves shall be complete with cast iron body and bolted cover, plain end inlet and outlet, bronze flap and bronze valve seat. Valve shall be normally open.
 - .1 Unit up to 300 mm (12 in.) underground, shall be complete with access cover at grade and extension sleeve between cover and valve casing.
 - .2 Unit more than 300 mm (12 in.) underground, shall be complete with minimum 600 mm (24 in.) dia. galvanized steel, concrete or vitrified clay tile access pit with 600 mm (12 in.) dia. heavy duty scoriated manhole cover and frame.
- 2.1.24. Provide extendable backwater valve complete PVC extendable valve body and normally open cassette for services 100 mm (4 in.) and smaller. Extend to grade with PVC DWV pipe and provide 19 mm (3/4 in.) cassette pipe extension to grade for cassette retrieval. Provide cleanout access suitable for floor finish in accordance with Section 22 05 76.00 - CLEANOUTS. Backwater Valve shall be Mainline Adapt-A-Valve Model ML-#XP to suit size of drain.
- 2.1.25. Water hammer arresters shall be stainless steel bellows type and shall bear the Plumbing and Drainage Institute seal of approval. JR Smith 5000 Series, Zurn Z1700, Mifab WHB, Watts SS Series. Piston type are not permitted.

- 2.1.26. Exterior site sewers shall be PVC non-pressure, SDR 28, cement, or concrete of class and type to suit depth of trench and bedding. PVC non-pressure sewer piping shall be IPEX for sizes 100 mm (4 in.) to 150 mm (6 in.) conforming to CSA B182.1 "Plastic drain and sewer pipe and pipe fittings" and ASTM D3034 "Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings." For sizes 200 mm (8 in.) to 375 mm (15 in.) shall be IPEX conforming to CSA B182.2 "PSM type polyvinylchloride (PVC) sewer pipe and fittings" and ASTM D3034. For size 450 mm (18 in.) to 1200 mm (48 in.) shall be IPEX conforming to CSA B182.4 "Profile polyvinylchloride (PVC) sewer pipe and fittings" and ASTM F794 "Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter." Sewers shall be laid in accordance with manufacturer's written instructions and in accordance with regulatory requirements.
- 2.1.27. Exterior site PVC pressure piping shall be IPEX Blue Brute conforming to AWWA C900 "Polyvinyl chloride (PVC) pressure pipe and fabricated fittings, 4 in. through 60 in. (100 mm through 1,500 mm)" and CSA B137.3 "Rigid polyvinylchloride (PVC) pipe and fittings for pressure applications" standards laid in accordance with the manufacturer's written instructions and in accordance with regulatory requirements.
- 2.1.28. Exterior site PVC pressure piping expansion joints for differential settlement and seismic movement:
- .1 Manufactured of ductile iron conforming to the material requirements of ASTM A536 "Standard Specification for Ductile Iron Castings" and ANSI/AWWA C153/A21.53 "Ductile-iron Compact Fittings for Water Service."
 - .2 Pressure test each flexible expansion joint prior to shipment against its own restraint to a minimum of 2413 kPa (350 PSI) for 76 mm (3 in.) through 406 mm (16 in.) and 1724 kPa (250 PSI) for 457 mm (18 in.) and larger. Provide a minimum 2:1 safety factor, determined from the published pressure rating.
 - .3 Provide flexible expansion joints that consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 20° for sizes 102 mm (4 in.) through 305 mm (12 in.); 15° for sizes 356 (14 in.) through 914 mm (36 in.) and 12° for size 1219 mm (48 in.). Provide flexible expansion fitting that does not expand or exert an axial imparting thrust under internal water pressure. Provide flexible expansion fitting that does not increase or decrease the internal water volume as the unit expands or contracts. Provide minimum total linear travel of 203 mm (8 in.).
 - .4 Line all internal surfaces (wetted parts) with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 "Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings." Provide EPDM sealing gaskets. Provide coatings that meet NSF/ANSI/CAN 61 "Drinking Water System Components."
 - .5 Coat exterior surfaces with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C116/A21.16 "Protective Fusion-Bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings."
 - .6 Include polyethylene sleeves, meeting ANSI/AWWA C105/A21.5 "Polyethylene Encasement for Ductile-Iron Pipe Systems" for direct buried applications.
 - .7 Provide manufacturer's certification of compliance to the above standards and requirements.
 - .8 Provide flexible expansion joints: Force Balanced FLEX-TEND or Victaulic 257 Dynamic Movement Joint.
- 2.1.29. Manual flow balancing valves up to 2 in. (50.8 mm): Victaulic TA Series 790 on domestic water recirculation system.
- 2.1.30. Thermostatic mixing valves

- .1 Thermostatic mixing valves shall be Lawler Series 801 (19 mm (3/4 in.) inlet and 25 mm (1 in.) outlet) High-Low Water Mixer combination thermostatic and pressure balanced water controller, liquid filled motor. The valve shall maintain output temperature for changes in inlet pressure and temperature. Valve construction shall be bronze body and stainless steel piston and liner. Mixing valve shall include a union end stop and check valve with removable strainer on each inlet. Complete with 0 - 200 deg. F. dial thermometer and shut off valve on tempered water outlet.

2.2. FLUSHING AND DISINFECTING:

2.2.1. Chlorine:

- .1 Sodium hypochlorite to ANSI/AWWA B300 "Hypochlorites."

3. Execution

3.1. INSTALLATION

- 3.1.1. Valves shall be provided as shown and as required for the satisfactory operation and control of all equipment and shall be installed to enable each piece of equipment to be isolated.
- 3.1.2. Isolation valves shall be installed at the base of each riser and at each branch take-off. Where the equipment is to be isolated within easy view of and not more than 6000 mm (20 ft.) from the main, at the branch take-off, then the branch take-off valve may serve as the equipment isolating valve.
- 3.1.3. Drain valves shall be installed at each low point in the piping systems and at each tank.
- 3.1.4. Blow-off valves shall be provided on each 65 mm (2-1/2 in.) strainer and larger.
- 3.1.5. Globe valves shall be installed as shown and in each bypass.
- 3.1.6. Install manual flow balancing valves where shown on the Drawings or where required.
- 3.1.7. Install automatic flow balancing valves where shown on the Drawings or where required.
- 3.1.8. Where combined domestic water and fire protection services are provided, provide master isolation supervised shut off valve. Refer to Section 21 13 00.00 – SPRINKLER SYSTEMS for valve specifications.
- 3.1.9. Install building premise isolation back flow prevention as required by CSA B64.
- 3.1.10. Install reduced pressure backflow preventers where required by CSA B64 and in the following locations:
 - .1 Chilled water systems make-up
 - .2 Heating water systems make-up
 - .3 Glycol systems make-up (where provided)
 - .4 Laboratory sink supply systems, both hot and cold water
 - .5 Fume hood plumbing systems
 - .6 RO and other systems not used as potable water
 - .7 Upstream of all trap seal primer assemblies unless the trap seal primer assembly includes a 1" air gap, or other device suitable for Severe Hazard sources
 - .8 Where shown on the Drawings
 - .9 As requested by the Authority Having Jurisdiction
- 3.1.11. Install check valves as shown, and as required by the Authority Having Jurisdiction.

- 3.1.12. Buried piping shall be of a class and type and laid in a bedding as noted and/or as recommended by the manufacturer and any Authority Having Jurisdiction. Class of pipe and bedding shall take into consideration location, size of pipe, type, width and depth of trench and type of soil.
- 3.1.13. The following publications shall be used to establish class of bedding and class of piping for installation other than the above. They shall also serve as guide for preparation of bedding, installation and testing.
- .1 Cast Iron Soil Pipe and Fittings Handbook of the Cast Iron Soil Pipe Institute.
 - .2 Sewer pipe manual of Canron.
 - .3 Sewer Design & Construction of the Water Pollution Control Federation.
 - .4 The Blue Brute and Ring Tite PVC gravity sewer pipe installation Guide by Manville.
- 3.1.14. Pipe passing under a driveway or parking lot with less than 1.5 m (5 ft.) of cover shall be encased in 150 mm (6 in.) of 13800 kPa (2000 psi) concrete on top, bottom and sides.
- 3.1.15. Provide thrust blocks of 20 MPa (3000 psi) concrete at each tee, elbow, valve and other fitting where thrust forces could occur. Thrust blocks shall be sized to suit the local authorities' requirements, but in no case be smaller than 150 mm (6 in.) greater on all sides than the pipe served.
- 3.1.16. PC4 jointing material shall not be used on buried piping. PC4 or similar jointing material shall be used for caulking waste pipes from sinks or dishwashers and other waste pipes carrying hot discharge liquids.
- 3.1.17. Connections between copper and steel pipe shall be made with brass or bronze fittings where other type of connection is not specified in regulations.
- 3.1.18. All piping shall run parallel with closest wall.
- 3.1.19. Piping in walk-in pipe spaces shall be installed as close to one wall as possible.
- 3.1.20. Each water hammer arrester shall be accessible for service and replacement. They shall be installed in compliance with the recommendations of the Plumbing and Drainage Institute as found in Standard PDI-WH 201 "Water Hammer Arresters." The water pressure at fixture level on the first floor is 550 kPa (80 psig).
- 3.1.21. Slope all drains and vents in accordance with the Plumbing Code but not less than the minimum slopes shown on the Drawings. Slope all water lines 25 mm in 12 m (1 in. in 40 ft.) unless shown otherwise.
- 3.1.22. Install vent piping in accordance with requirements of the authority having jurisdiction.
- 3.1.23. Vent stack covers shall be properly sized for each vent penetrating the roof. Division 23 shall supply vent stack covers for installation and flashing by the Roofing Contractor.
- 3.1.24. Provide bird screen on all vents terminating horizontally, with a gooseneck or other configurations where a vent stack cover is not provided.
- 3.1.25. Securely attach vent piping to the building structure immediately below the roof deck and above the first coupling where vents penetrate sloped roofs.
- 3.1.26. Refer to Section 22 63 53.00 - LABORATORY LIQUID SYSTEMS.
- 3.1.27. Provide an isolation valve downstream of all flow balancing valves on the domestic water distribution.
- 3.1.28. Provide all mechanical piping and fittings within the cistern. Rainwater cistern floating device shall intake water 150 mm below the water surface and shall ensure that the foot valve is always submerged.
- 3.1.29. Provide a thermostatic mixing valve on discharge of domestic hot water systems.

- 3.1.30. Grooved pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. All grooved Products to be from a single manufacturer. All couplings shall meet the manufacturer's standards for visual inspection. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Install in accordance with manufacturer's latest recommendations. A manufacturer's factory trained representative shall periodically visit the site and review the installation for best practices. The Contractor shall correct any identified deficiencies. Grooved Product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined by the manufacturer prior to the completion of the Work.
- 3.1.31. Install flexible expansion joints in the locations indicated on the Drawings and as required by piping manufacturer.
- 3.1.32. Where site servicing expansion joints are required, provide signed and sealed engineered drawings for review and record.
- 3.1.33. Main Incoming Domestic Cold Water Filtration:
- .1 Insulate per manufacturer's written recommendations.
 - .2 Pipe backwash flush connection to nearest drain using an indirect connection.
- 3.1.34. Do not install combustible (e.g. PVC, etc.) piping in a vertical service space.
- 3.2. FLUSHING AND DISINFECTING
- 3.2.1. Flush and disinfect all new or reworked domestic water piping, ensure water flows through all fixtures, hose outlets, service connections and/or any other potable water outlet. Remove sediment from aerators as required.
- 3.2.2. Provide circulating pumps, connections and valves as required for complete flushing and disinfection of the system.
- 3.2.3. When flushing is complete, disinfect the piping with a solution of chlorine in accordance with ANSI/AWWA C651 "Disinfecting Water Mains."
- 3.2.4. Test water samples from disinfected water system at a certified laboratory for purity and conformance with governing standards.
- .1 Submit a copy of the test results prior to building occupancy.

END OF SECTION

22 11 23.29 Circulators

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Circulators, in the line type with flanged inlet and outlet, mechanical seal and suitable for 125 psig working pressure from:

- .1 Armstrong
- .2 Grundfos-Paco
- .3 Xylem Bell & Gossett
- .4 Patterson Pump Company
- .5 Taco Industries
- .6 Wilo

2.1.2. For domestic water systems (potable) pump body shall be lead free bronze or stainless steel with impeller meeting the low lead requirements of NSF/ANSI/CAN 372 "Drinking Water System Components - Lead Content" for all wetted parts.

2.1.3. All systems except domestic water pump shall be cast iron, steel impeller and stainless steel shaft.

2.1.4. Pump capacity shall be as shown in the Pump Schedule.

3. Execution

3.1. INSTALLATION

3.1.1. Support pump as shown on Standard Details.

END OF SECTION

22 13 19.13 Floor Drains

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Floor drains shall be Jay R. Smith, Mifab, Watts, or Zurn.

2.2. FINISHED AREAS

2.2.1. Floor drains in finished areas shall be all coated cast iron body, flashing clamp with seepage openings and adjustable 127 mm (5") diameter nickel bronze 6.35 mm (1/4") thick strainer, secured with SS screws, 100 mm (4") throat on strainer. Drain shall be complete with trap primer connection. Jay R. Smith 2005A05NB-P050, Zurn ZN-415-B5, Mifab F1100C-5-1, Watts FD-100-C-A5-1.

2.2.2. Floor drains in finished areas and stainless steel top shall be all coated cast iron body, flashing clamp with seepage openings and adjustable 127 mm (5") diameter stainless-steel heavy duty strainer with No. 4 satin finish, secured with SS screws, 100 mm (4") throat on strainer. Drain shall be complete with trap primer connection. Jay R. Smith 2005-A05SS-P050, Zurn ZXSS-415-A5, Mifab F1000C-5-3, Watts FD-1100-C-5-3.

2.2.3. Floor drains in quarry or mosaic tiled areas shall be similar to floor drains in finished areas but with 127 mm x 127 mm (5" x 5") square nickel bronze strainer. Jay R. Smith 2005-B05NB-P050, Zurn ZN-415-Y5, Mifab F1100C-S5-1, Watts FD-100-C-L5-1.

2.2.4. Floor drains in quarry or mosaic tiled areas and stainless steel top shall be similar to floor drains in finished areas but with 127 mm x 127 mm (5" x 5") square stainless-steel strainer with No. 4 satin finish. Jay R. Smith 2005-B05SS-P050, Zurn ZS-415-Y5, Mifab F1000C-S5-3, Watts FD-1100-C-L5-3.

2.2.5. Funnel floor drains in finished areas shall be similar to floor drains in finished areas but with minimum nominal 127 mm (5") dia. strainer, full opening for funnel and nominal 75 mm x 225 mm (3 in. x 9 in.) oval funnel. Jay R. Smith 2005-A05-NB-3591-OT-P050, Zurn ZN-415-BF, Mifab F1100C-EG-1, Watts FD-100-C-EG-1.

2.2.6. Floor drains in Safety Sheet Vinyl Flooring Areas shall be similar to floor drains in finished areas but with 2-piece flashing clamp collar. Jay R. Smith 2051, Zurn ZN-415-R9, Mifab F1100C-FC9-1, Watts FD-100-C-FC9-1.

- 2.2.7. Hub drains shall be similar to floor drains in finished areas but with cast iron hub. Jay R. Smith 2005-2645, Zurn Z-415-S, Mifab F1100C-DD-50, Watts FD-100-DD-50.
- 2.3. NON-FINISHED AREAS
- 2.3.1. Floor drains in non-finished areas: coated cast iron body, drainage flange, adjustable nominal 200 mm (8 in.) dia. heavy-duty strainer and complete with trap primer connection. Jay R. Smith 2110, Zurn Z-536-8, Mifab F1320C-4, Watts FD320-4.
- 2.3.2. Funnel floor drains in non-finished areas: similar to floor drains in non-finished areas but with nominal 75 mm x 225 mm (3 in. x 9 in.) oval funnel. Jay R. Smith 2110-3591, Zurn Z-536-8-F0, Mifab 1320C-4-G-50, Watts FD320-4-G-50.
- 2.3.3. Plenum drains (Plenum Floor Drains) for use in suspended sheet metal plenums: 225 mm (9 in.) overall dia. strainer with screwed attachment for sheet metal pan. Jay R. Smith SQ-4-1753-SM, Zurn ZN-211-R9, Watts FD-200-FC9-1.
- 2.3.4. Floor drains in floating floor areas: cast iron body, drainage flange, nominal 200 mm (8 in.) dia. heavy-duty strainer, movement compensator and vibration isolator. Jay R. Smith 9340, Zurn Z-556-FS, Mifab F1600C-4, Watts FD-620-C.
- 2.3.5. Funnel floor drains in floating floors: similar to floor drains in floating floors but with nominal 75 mm x 225 mm (3 in. x 9 in.) oval funnel. Jay R. Smith 9340-3591, Zurn Z-556-FS-F0, Mifab F1600C-4-G-50, Watts FD-620-C-G-50.
- 2.3.6. Floor drains in transformer vaults: coated cast iron or steel body, with heavy duty 300 mm x 300 mm (12 in. x 12 in.) tractor grate, body grounding screw, side outlet connection, bronze backwater valve/flame arrestor assembly and gasketed internal cleanout cover. Jay R. Smith 2235 EVFAHQ, Zurn ZZ-HQ-605-1-HVV, Mifab F1560-4-8-GS, Watts FD-460-F-9-46-4.
- 2.3.7. Floor drains in parking structures and ramps: to the requirements of CSA-S413 "Parking Structures" for materials and corrosion resistance and with double drainage, anti-ponding top, sediment bucket and membrane clamp. Supply drain complete with membrane extension as required. Jay R. Smith SQ-2-2347, Zurn Z-535, Mifab F1510-CSA, Watts FD-490-F-80.
- 2.3.8. Garage floor drains at slab on grade: heavy duty, coated cast iron, with heavy duty 300 mm x 300 mm (12 in. x 12 in.) tractor type grate and sediment bucket. Non-adjustable drainage flange with clamp where moisture proof membrane is installed. Jay R. Smith SQ-2-1717-B, Zurn Z-610-H-Y, Mifab F1440C-4-5, Watts FD-460-A-C-4-5.
- 2.3.9. Garage floor drains at slab on grade: heavy duty, coated cast iron, with heavy duty 300 mm x 300 mm (12 in. x 12 in.) tractor type grate and sediment bucket. Adjustable drainage flange to suit topping depths with clamp where moisture proof membrane is installed. Jay R. Smith SQ-2-1717-ADJ-B, Zurn Z-610-H-ADJ-Y, Mifab F1440C-4-5, Watts FD-460-AF-C-4-5.
- 2.3.10. Catch basin floor drains: heavy duty coated top with coated steel sump, side outlet for sand storage and 600 mm x 600 mm (24 in. x 24 in.) tractor grate. Jay R. Smith 8930-M, Zurn ZF-799-75-AF, Mifab 1570, Watts FD-410.
- 2.3.11. Trench drain systems shall be precast polymer concrete, nominal 125 mm (5 in.) wide sloped modular system with interlocking components and extra heavy-duty class "E" ductile iron grates and integral channel rail frame, catch basin, foul air trap as required. Provide minimum 100 mm (4 in.) bedding of concrete around trench. Jay R. Smith 9895, ACO S100K.
- 2.3.12. Trench drain shall be all stainless-steel body, frame and grate. Grate shall be nominal 150 mm (6 in.) and designed for class "E" traffic loading. Jay R. Smith SQ-2-1744-SS-M, Zurn Z890-SBG.
- 2.3.13. Elevator pit drains: Vertical wall or angled scupper drain, coated cast iron body, secured cast iron grate, clamping collar. Zurn Z187 or Z629-C-LV, Jay R. Smith 1510 or 2090-C, Mifab R1310-50, Watts RD-270-50.

- 2.3.14. Electronic automatic trap seal primer system with 12 mm (1/2 in.) connection, complete with integral ball valve and CSA B64 backflow prevention to the requirements of the Authority Having Jurisdiction. Pre-pipe the unit with a copper manifold and distribution system suitable for the number of drains served. Provide electrical components with a single point power connection at 120 V. Include with unit a manual override switch and 24-hour timer with relay and adjustable delay. Factory assemble all components and install into a coated steel box with access door for surface mounted installation. Mifab MI 100-UA series; Zurn Z1020 series; Precision Plumbing Products PT Series; or Smith Fluid Controls 270/271/272 Series.
- 2.3.15. Where acceptable to the Authority Having Jurisdiction, provide trap seal protection device in lieu of hydronic. Trap seal protection is permitted in the following locations:
- .1 .
 - .2 Trap Guard Pro Vent System, preassembled inline floor drain trap sealer, commercial grade ABS housing and proprietary neoprene diaphragm with soft rubber sealing gasket, ASSE 1072 "Performance Requirements for Barrier Type Trap Seal Protection for Floor Drains" AF-GW rating or approved equal. Install in accordance with manufacturer's recommendations.
 - .3 The use of a trap seal protection device does not negate the requirement for the installation of a trap.
- 2.4. LOCATED OUTSIDE OF THE BUILDING ENVELOPE
- 2.4.1. Trench drains located outside of the building envelope: pre-sloped trench drain system with ductile iron frame, nominal 150 mm (6 in.) wide sloped modular system with interlocking components and extra heavy-duty class "F" ductile iron grates and integral channel rail frame and catch basin. Provide minimum 100 mm (4 in.) bedding of concrete around trench. Acceptable materials include precast polymer concrete, polypropylene, and HDPE. Watts Dead Level D, Zurn Z886, or approved equivalent.
- 2.4.2. Trench drains located outside of the building envelope: pre-sloped trench drain system with ductile iron frame, nominal 300 mm (12 in.) wide sloped modular system with interlocking components and extra heavy-duty class "F" ductile iron grates and integral channel rail frame and catch basin. Provide minimum 100 mm (4 in.) bedding of concrete around trench. Acceptable materials include precast polymer concrete, polypropylene, and HDPE. Watts Dead Level DX, Zurn Z882, or approved equivalent.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Provide floor drains in air plenums on the suction and discharge side of fans with deep seal traps.
- 3.1.2. Provide electronic trap seal primer assemblies for all floor drain traps. Trap primer shall be installed at the nearest cold water served fixture or faucet, except drinking fountains.
- .1 Provide access to primer assembly for repair or replacement.
 - .2 Provide a globe valve on the water supply for regulation and shut-off.
 - .3 Where integral backflow prevention is not sufficient to meet the requirements of CSA B64, provide a reduced pressure backflow prevention device on the water supply to the trap seal primer in a suitable location and discharge piped to drain.
- 3.1.3. Provide a running trap and cleanout for each pit drain. For elevator pits provide an external backwater valve in accordance with Section 22 11 13.00 - PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM).

- 3.1.4. Provide a backwater valve in accordance with Section 22 11 13.00 - PIPES, VALVES AND FITTINGS (PLUMBING SYSTEM) on floor drains within walk-in coolers before connecting to sanitary drainage system.

END OF SECTION

22 13 29.13 Sump Pumps

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.2.2. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Obtain flow tests to determine actual flow rates before ordering pumps.

2.1.2. Pump capacity shall be as shown in the Pump Schedule.

2.1.3. Vertical Column Sump Pumps

.1 Sump pumps, duplex pumping unit with vertical shaft driven single stage pumps from:

.1 Armstrong

.2 Pentair - Aurora

.3 Grundfos - LaBour Taber

.4 Wilo

.2 For sanitary drainage systems the inlet shall be open to the impeller and it shall be capable of handling typical sewage without clogging.

.3 Pumps on sanitary sewer systems conveying solid waste shall be grinder type.

.4 For storm and weeping tile drainage systems the inlet shall be complete with a screen over the impellor.

.5 Shaft shall be rust-resistant alloy steel. Pump design shall permit easy adjustment of the impeller in the volute. Bearings shall be grease lubricated with grease fittings anchored on cover plates.

.6 Provide intermediate bearings complete with lubrication lines for all pumps in pits over 1.5 m (5 ft.) deep. Provide intermediate couplings to facilitate pump removal in limited headroom conditions.

2.1.4. Submersible Pumps

.1 Non-clog submersible pumps from:

.1 Leader (Barnes)

- .2 Liberty Pumps
 - .3 Grundfos – Chicago
 - .4 Xylem – Flygt
 - .5 Pentair – Hydromatic.
 - .6 Wilo
 - .2 Pumps shall be cast iron casing with heavy duty base bronze wear ring, two vane impeller, heavy duty ball bearings, double mechanical seals, stainless steel shaft and double epoxy potted and compression fitted power cord and control cord fittings.
 - .3 Pumps on sanitary sewer systems conveying solid waste shall be grinder type.
 - .4 Pump shall be complete with coupling kit and guide rail assembly to allow for pump removal without entering the pit. Provide chain on pump and hoisting ring in structure above for hoisting pump.
- 2.1.5. Controls
- .1 There shall be two float operated switching mechanisms.
 - .2 The switching mechanism connected to one of the floats shall be a mechanical alternator. Action of the alternator shall be to alternate the lead pump in sequential starts. The switching mechanism connected to the other float shall start both pumps should the water level rise above the operating level of the alternator float.
 - .3 There shall be a high water alarm switch complete with transformer and bell, and auxiliary contacts for wiring to the building BAS system.
 - .4 All controls shall be mounted in a CSA Type 3R control panel and shall be complete with all starters, power wiring, control wiring, hand-off-auto switch and LED pilot light for each pump, transformer and wiring to the alarm panel and shall require only a single power supply by the Electrical Division. All conduit shall enter from the bottom only.
 - .5 System shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be 10,000 A Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.
- 2.1.6. Cover and Sump Pit
- .1 Pumps shall be mounted on/covered by a galvanized steel cover plate that shall be sufficiently strong and rigid to support the pump or pumps as required, pump accessories and service technician without vibration or deflection. An inspection cover shall be provided in the cover plate.
 - .2 A galvanized steel frame shall be provided for receiving the cover plate in a concrete sump. Frame shall include a gasketed recess dimensioned for the cover plate, stainless steel threaded studs and nuts for fastening the cover and concrete anchors welded on at approximately 450 mm (18 in.) centres.
 - .3 The size of the cover plate and frame shall be determined from the pit size shown on the Drawings.
 - .4 Gasket all openings in cover plate and frame.
 - .5 Provide frames and cover plates for sand traps and inspection pits. Material shall be as specified for main cover plate.
 - .6 Provide galvanized steel ladder rungs at 300 mm (12 in.) on centres for full depth of all pits.
- 2.1.7. Prefabricated Sump Pit

- .1 Provide pre-fabricated fibreglass sump pits as indicated on the Drawings. Fibreglass basin shall be as follows:
 - .1 Fabricated from commercial grade polyester with commercial grade continuous strand or continuous mat glass fibre with coupling agent.
 - .2 Wall thickness as necessary to withstand wall collapse or buckling based on hydrostatic loading of 62.4 lbs per cu. ft., a saturated soil weight of 120 lbs per sq. ft. and a soil modulus of 700 lbs per sq. ft. Wall thickness to meet the pipe stiffness values as specified in ASTM D3753 "Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Manholes and Wetwells". Wet well Fiberglass Reinforced Plastic (FRP) laminate constructed to withstand or exceed two times the assumed loading on any depth of the wet well.
 - .3 Wet well top flange outside diameter of at least 4.0 inches greater than the inside diameter of the wet well with a four or six-hole pattern to match the cover. Hole pattern complete with fully encapsulated stainless steel threaded inserts.
 - .4 Provide pump mounting studs, and fiberglass stud plates.
 - .5 Provide stainless steel float brackets.
 - .6 Complete with lifting lugs, threaded couplings, and pipe grommet inlet hubs.
 - .7 Acceptable manufacturers: TOPP Industries Inc., Crane, Green-Turtle, AK Industries, Liberty.

3. Execution

3.1. INSTALLATION

- 3.1.1. Provide gate valve, check valve and union or flange as applicable on pump discharge pipes and union or flange as applicable on vent pipe for sanitary pits.
- 3.1.2. Check valves downstream of pumps shall be swing type with external lever and adjustable weight.
- 3.1.3. The frame, intermediate platform, and ladder rungs shall be provided to Division 3 for setting in place.
- 3.1.4. If the main control panel is shipped without a splitter to serve the alarm panel, supply and install an additional junction box before the control panel to serve all related panels.
- 3.1.5. Intermediate platforms shall be equally spaced over the height of the pit and the maximum distance between shall not exceed 4.5 m (15 ft.). Platforms shall be installed clear of pump removal space.
- 3.1.6. Install fibreglass sump base flange in light weight concrete anchor slab prior to backfilling.

END OF SECTION

22 14 26.13 Roof Drains

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Provide roof drains by Jay R. Smith, Zurn, Mifab, or Watts, unless indicated otherwise.

2.1.2. Provide roof drains in metal decks or poured concrete roofs as follows: coated cast iron body, large sump, wide non-crimping flange, vandal proof aluminum or ductile iron mushroom dome strainer, extension frame to suit thickness of insulation, sump receiver, under-deck clamps and flashing clamp with integral gravel stop. Jay R. Smith 1010-AD-E-R-C-U, Zurn ZA-100-E-C-R-VP, Mifab R1200-6-M-B-U-V, Watts RD-100-B-D-K80-L-V.

2.1.3. Provide planter drains as specified above but with the dome covered with stainless steel or bronze mesh.

2.1.4. Provide roof drains for flooded roofs as follows: as specified above but complete with flooding dam to provide approximately 50 mm (2 in.) depth of flooding.

2.1.5. Where flow quantities for roof drains are shown, provide drains as specified above but equipped with weirs to give flow quantities shown.

2.1.6. Provide roof drains in IRMA or upside-down roofs as follows: similar to drains specified above but with cast extensions to suit full depth of gravel and/or pavers and insulation and cast slotted surround for full depth of gravel and insulation for all openings larger than 12 mm (1/2 in.). Jay R. Smith 1012-AD-LR-C-U, Zurn ZA-100-SE-C-R-VP, Mifab R1200-HC-6-M-B-U-V, Watts RD-100-CH-B-D-K80-L-V.

2.1.7. Provide promenade drains in walking areas as follows: as specified above but with adjustable ductile iron or cast iron 300 mm x 300 mm (12 in. x 12 in.) square grate with cast nickel-bronze veneer.

2.1.8. Provide promenade drains shown as stainless steel as follows: as specified above but with adjustable ductile iron or cast iron 300 mm x 300 mm (12 in. x 12 in.) square grate with cast stainless steel veneer, all polished to No. 4 satin finish.

- 2.1.9. Provide roof drains in precast concrete roof as follows: coated cast iron body, with flange, small aluminum or ductile iron mushroom dome, sump receiver, under-deck clamp flashing clamp with integral gravel stop. Jay R. Smith 1330-CID-E-R-C-U, Zurn Z-125-C-E-R-VP, Mifab R1100-6-M-B-U-V, Watts RD-200-B-D-K80-L-E.
- 2.1.10. Provide screens as required to prevent gravel from entering the drain pipes.
- 2.1.11. Provide scupper drains as follows: coated cast iron body with flashing flange removable clamp and nickel bronze oblique angle grate. Provide outlet of 90 Degrees or 45 Degrees as required. Jay R. Smith 1510-SG-NB or Jay R. Smith 1530-SG-NB, Zurn ZN-187-TS or Zurn ZN-189-OB-TS, Mifab R1300-1 or Mifab R1310-1, Watts RD-270-1, or Watts RD-270-A-1.
- 2.1.12. Provide scupper drains as follows: coated cast iron body with flashing flange removable clamp and coated cast iron oblique angle grate. Provide outlet of 90 Degrees or 45 Degrees as required. Jay R. Smith 1510-SG or Jay R. Smith 1530-SG, Zurn Z-187-TS or Zurn Z-189-OB-TS, Mifab R1300 or Mifab R1310, Watts RD-270 or Watts RD-270-A.
- 2.1.13. Provide roof drains with integrated emergency overflow drains in metal decks or poured concrete roofs as follows: coated cast iron body, large sump, integral 150 mm (6 in.) diameter cast iron standpipe, dual outlet, wide non-crimping flange, vandal proof aluminum or ductile iron mushroom dome strainer, extension frame to suit thickness of insulation, sump receiver, under-deck clamps and flashing clamp with integral gravel stop. Jay R. Smith 1077-45, Zurn 100C Froet Drain, Mifab R1200-SO, or Watts RD-700.
- 2.1.14. Provide downspout and emergency overflow roof drain outlet nozzles as follows: cast nickel bronze body, anchor flange, countersunk mounting holes, perforated bird screen. Jay R. Smith 1770/1771, Zurn 199, Mifab R1940/1950, or Watts RD-940.
- 2.1.15. Provide downspout and emergency overflow roof drain outlet covers as follows: 304 stainless steel body, vandal proof hinged perforated bird screen, anchor flange, countersunk mounting holes. Jay R. Smith 1775, Zurn 199-DC, Mifab R1960, or Watts RD-950.
- 2.1.16. Provide expansion compensators as follows: Jay R. Smith 1710, Zurn Z-190, Mifab R1900, or Watts RD-900.
- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. For roof drains connected to vertical rain water leaders with less than 1200 mm (4 ft.) of horizontal offset, provide complete with expansion compensators.
 - 3.1.2. Turn drain bodies over to roofing and waterproofing trades on site for priming and setting into bearing pads of waterproofing materials.
 - 3.1.3. Provide control flow roof drains with a lamacoid tag affixed to the dome indicating the following:
 - .1 DO NOT REMOVE, ADJUST, OR TAMPER WITH FLOW CONTROL WIER.

END OF SECTION

22 15 00.00 Machine Shop Air Compressors

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.2.2. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

.1 The compressor shall be a single stage, two cylinder, reciprocating air-cooled machine. The compressor shall be complete with kW (hp) electric motor, belt drive with guard and discharge line check valve.

.2 The compressor unit shall be mounted on an L (US gal.) horizontal air receiver. Receiver shall be complete with pressure switch, safety relief valve and pressure gauge.

.3 The compressor unit shall supply L/s (cfm) of free air at an operating pressure of 690 kPa (100 psig).

.4 The operating control of the compressor unit shall be automatic start and stop.

.5 The compressed air supply system shall be complete with air cleaners, fog lubrications, air filters, pressure regulators, automatic couplings, air cocks, moisture traps and all other fittings necessary to perform the required operation in the individual workshops.

2.1.2. System shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.

3. Execution

3.1. INSTALLATION

3.1.1. Resiliently mount the compressor and air receiver unit, as specified under Section 20 05 48.00 - VIBRATION AND NOISE CONTROL.

END OF SECTION

22 15 13.00 Compressed Air Piping Systems (Service Air)

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Conform to the requirements of Authority Having Jurisdiction.

1.1.3. Provide an installation that is compliant with CSA B51 "Boiler, pressure vessel, and pressure piping code" and the ASME standards referenced therein.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Compressed air up to 65 mm (2-1/2 in.) shall be copper tubing type K to ASTM B88 "Standard Specification for Seamless Copper Water Tube," fittings shall be wrought copper, silver soldered, ANSI B16.22 "Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings."

2.1.2. Systems, or parts of systems, in excess of 15 psig and/or larger than 19 mm (3/4 in.) shall meet the requirements of TSSA. Soldered joints are not permitted and shall be brazed.

2.1.3. Compressed air 65 mm (2-1/2 in.) and larger shall be steel pipe galvanized Schedule 40 to ASTM A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless," fittings malleable iron ASTM A197 "Standard Specification for Cupola Malleable Iron," 300 psi WSP threaded ANSI/ASME B16.3 "Malleable Iron Threaded Fittings Classes 150 and 300."

2.1.4. Gate valves 50 mm (2 in.) and smaller shall be 860 kPa (125 psi) WSP bronze body, rising stem, solder ends or screwed to solder adaptor.

2.1.5. Gate valves 65 mm (2-1/2 in.) and larger shall be 860 kPa (125 psi) WSP iron body bronze mounted, OS&Y flanged ends.

2.1.6. Drain valves shall be 1380 kPa (200 psi) non-shock WOG 19 mm (3/4 in.) size, bronze body, threaded garden hose end, chain and cap.

2.1.7. Check valves shall be 2068 kPa (300 psi) non-shock, bronze body, stainless steel disc, guided spring, silent type.

3. Execution

3.1. INSTALLATION

- 3.1.1. Provide drip leg at each low point. Drip leg shall be a minimum of 300 mm (12 in.) long and complete with drain valve.

END OF SECTION

22 33 00.00 Domestic Electric Hot Water Heaters

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.2.2. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.2. Tank based domestic electric hot water heaters:

- .1 Provide CSA approved domestic electric hot water heaters by John Wood, Bradford White, AO Smith or Rheem.
- .2 Provide glass lined steel tank, factory insulated and covered with an enamelled steel jacket. Provide tank rated for 860 kPa (125 psi) working pressure.
- .3 Provide heater elements of electric immersion type located at the top and bottom of the tank and complete with thermostats. Arrange elements to operate alternatively or simultaneously, as shown. Provide an additional high limit thermostat that prevents overheating. Provide access panels in jacket that provide access to thermostats and elements.
- .4 Provide tanks complete with temperature pressure relief valve. Pipe relief valve to nearest drain.
- .5 Provide tanks of size and heaters of capacity shown.
- .6 Provide tanks of size and heaters of capacity as shown on the Domestic Hot Water Heater Schedule.

2.1.3. Compact point of use tankless electric domestic hot water heaters:

- .1 Provide compact point of use tankless heaters that are:
 - .1 98% efficient.
 - .2 Mounted under sinks or recessed inside a wall enclosure with an access door in washroom areas.
 - .3 CSA approved and UL listed.
 - .4 Complete with copper heat exchanger and copper sheathed heating elements.
 - .5 Manufactured by Bosch, Bradford White, Rheem or Chronomite.

- .2 Refer to Domestic Hot Water Heater Schedule for sizing.
- 2.1.4. System shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.

3. Execution

3.1. NOT USED

END OF SECTION

22 34 36.00 Domestic Water Storage Tanks and Heaters

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.2. Tank shall be Steelcraft Clemmer, Reco, PVI, or Niles Steel welded steel tank lined with Precrete or Alkrete. Flanged connections shall also be lined. Screwed connections shall be Everdur. Tanks shall be designed for 860 kPa (125 psig) working pressure and shall be complete with manhole, heater flanges and tapings for cold water, hot water recirculation, drain, relief valve, temperature controller and thermometer. Vertical tanks shall be complete with legs and floor flanges. Horizontal tanks shall be complete with saddles.

2.1.3. Heating element shall have seamless hard drawn copper tubes expanded into bronze tube sheets.

2.1.4. Connecting piping shall be installed to allow removal of heating element after disconnecting only two flanged pipe connections.

2.1.5. Controls for heating medium provided under Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).

2.1.6. Tank shall be complete with temperature pressure relief valve; valve shall be piped to drain.

2.1.7. Tank and heater shall be as shown on Drawings.

2.1.8. Tank and heater shall be as shown on Storage Tank and Heater Schedule.

3. Execution

3.1. NOT USED

END OF SECTION

22 42 00.00 Fixtures and Trim

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 – SHOP DRAWINGS.

1.2.2. For manual flush water closets located in barrier free applications, ensure that Shop Drawing clearly illustrates that flushing control is located on the transfer side (adjacent the clear floor space) of the water closet.

1.3. REFERENCES

1.3.1. Comply with CSA B45 Series of standards for fixtures.

1.4. MOCK UPS

1.4.1. Provide working mock up of ...

1.5. WARRANTY

1.5.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Plumbing fixtures shall be as indicated and specified with all required supports, accessories, drainage, vent and water connections to make the fixtures complete.

2.1.2. Fittings that supply water to a fixture shall not exceed the maximum flow rates in accordance with the following:

.1 Part 7 of the Building Code

2.1.3. Provide fixtures from American Standard, T&S Brass, Toto, Kohler, Franke, Zurn, Blanco, Mirolin or Novanni, equivalent to the fixtures specified. American Standard – Eljer and Placidus are not permitted. Provide white vitreous china fixtures unless indicated otherwise.

2.1.4. Provide fittings and trim from American Standard, T&S Brass, Kohler, Sloan, Chicago Faucets, Zurn, Moen, Symmons, or Delta/Cambridge except where specified otherwise. Provide polished chrome plated brass for all exposed valves, fittings, escutcheons, trim, etc., at each fixture, unless specified otherwise.

2.1.5. Provide Fixtures and Trim equal to Product Specification sheets.

2.1.6. Carriers shall be furnished for all wall hung water closets, urinals, and lavatories. Carriers shall be in conformance with Section 22 42 46.00 - FIXTURE CARRIERS.

2.2. WATER CLOSETS AND URINALS

- 2.2.1. All tanks of water closets shall be internally lined with anti-sweat insulation except pressure assist water closets.
- 2.2.2. For manual flush water closets located in barrier free applications, provide water closet with flushing control that is located on the transfer side (adjacent the clear floor space) of the water closet.
- 2.2.3. All flush valves shall have non-syphon by-pass and factory set rate of flow.
- 2.2.4. Water closets shown as type "WC-1 - Wall hung" shall be "High Efficiency", wall hung for flush valve, vitreous china, elongated syphon jet flush action bowl, 2-1/8" (54 mm) fully glazed internal trapway, 10" x 12" (254 mm x 305 mm) large water surface, 4.2 L (1.1 gal) per flush, 1-1/2" (38 mm) back spud, for use with concealed flush valve. American Standard AFWall Millennium FloWise Elongated 3351.101.020.020 HET, Zurn Z5615-BWL, Kohler Kingston High Efficiency Bowl K-84323-0.
- .1 Electronic "No Touch" flush valve unit for WC unit above shall be a safe 24 V system with fixed program-automatic 8 second blocking time, field adjustable flush delay setting, volume and sensing range, and manual over ride capability. Both a modular junction box and 120 to 24 VAC transformer are to be supplied with valve. The flush valve shall be high efficiency 4.2 L (1.1 US gal.) per flush, factory set flow, concealed quiet action, diaphragm flush and renewable seat with wheel handle angle pressure loss check stop. Unit to be supplied with metal recessed box and vandal resistant stainless steel face, measuring approximately 355 mm x 355 mm (14 in. x 14 in.) for both valve and sensor housing. Delta Commercial 1600T6103ARI and 1600T6103ATR with RP32508 transformer, Sloan "Royal Optima" 152-1.28--WB-ES-S with EL-154 transformer, Zurn ZEMS6152AV-HET-BX12 with P6000-HW6 power converter.
 - .2 Exposed flush valves for WC unit above shall be high efficiency 4.2 L (1.1 US gal.) per flush, quiet action, exposed diaphragm flush, renewable seat, polished chrome plated finish, volume control, vandal resistant cover screw, metal "non hold open" handle, 1 in. FIP/copper sweat inlet adaptor angle check stop with protecting cap, adjustable 120 mm (4¾ in.) plus or minus 11 mm (7/16 in.) inlet/valve outlet centers, vacuum breaker, 38 mm (1½ in.) dia. cover tube and wall flange, spud flange, and concealed spud nut. Sloan "Royal Flush" 111-1.28-YO, Zurn Z6000AV-HET-YO, Delta Commercial 81T201. Concealed power harvesting electronic "No Touch" flush valve unit for WC unit above shall be a safe 6 V system with fixed program-automatic 8 second blocking time, field adjustable flush delay setting, volume and sensing range, and manual over ride capability. Low battery alarm, 4 x AA battery backup. The flush valve shall be high efficiency 4.2 L (1.1 gal.) per flush, factory set flow, concealed quiet action, diaphragm flush and renewable seat with wheel handle angle pressure loss check stop. Unit to be supplied with metal recessed box and vandal resistant stainless steel face, measuring approximately 305 mm x 305 mm (12 in. x 12 in.) for both valve and sensor housing. Sloan Solis 8152-1.28 SWB, concealed Flushometer, or equal.
 - .4 Seats for WC unit above shall be elongated heavy-duty solid plastic open front toilet seat, less cover, with stainless steel check hinge and stainless steel posts, washers, and nuts. Bemis 1955-C, Centoco 500STSCC-001, Kohler Lustra K-4670-C, Olsonite 10CCSS, Zurn Z5955SS-EL.
- 2.2.5. Water closets shown as type "WC-2 - Wall hung" (Barrier Free Design) shall be "High Efficiency", wall hung for flush valve, vitreous china, elongated syphon jet flush action bowl, 2-1/8" (54 mm) fully glazed internal trapway, 10" x 12" (254 mm x 305 mm) large water surface, 4.2 L (1.1 gal) per flush, 1-1/2" (38 mm) back spud, for use with concealed flush valve. American Standard AFWall Elongated 3353.101.020.020 HET, Zurn Z5617-BWL, Kohler Kingston High Efficiency Bowl K-84323-0.

- .1 Electronic "No Touch" flush valve unit for WC unit above shall be a safe 24 V system with fixed program-automatic 8 second blocking time, field adjustable flush delay setting, volume and sensing range, and manual over ride capability. Both a modular junction box and 120 to 24VAC transformer are to be supplied with valve. The flush valve shall be high efficiency 4.2 L (1.1 US gal.) per flush, factory set flow, concealed quiet action, diaphragm flush and renewable seat with wheel handle angle pressure loss check stop. Unit to be supplied with metal recessed box and vandal resistant stainless steel face, measuring approximately 355 mm x 355 mm (14 in. x 14 in.) for both valve and sensor housing. Delta Commercial 1600T6103ARI and 1600T6103ATR with RP32508 transformer, Sloan "Royal Optima" 152-1.28 WB-ES-S with EL-154 transformer, Sloan Royal 152 ESS-1.28-ES-S, Zurn ZEMS6152AV-HET-BX12 with P6000-HW6 power converter.
 - .2 Exposed flush valves for WC unit above shall be high efficiency 4.2 L (1.1 US gal.) per flush, quiet action, exposed diaphragm flush, renewable seat, polished chrome plated finish, volume control, vandal resistant cover screw, metal "non hold open" handle, 1 in. FIP/copper sweat inlet adaptor angle check stop with protecting cap, adjustable 120 mm (4¾ in.) plus or minus 11 mm (7/16 in.) inlet/valve outlet centers, vacuum breaker, 38 mm (1½ in.) dia. cover tube and wall flange, spud flange, and concealed spud nut. Sloan "Royal Flush" 111-1.28-YG, Zurn Z6000AV-HET-YO, Delta Commercial 81T201-5.
 - .3 Concealed power harvesting electronic "No Touch" flush valve unit for WC unit above shall be a safe 6 V system with fixed program-automatic 8 second blocking time, field adjustable flush delay setting, volume and sensing range, and manual over ride capability. Low battery alarm, 4 x AA battery backup. The flush valve shall be high efficiency 4.2 L (1.1 US gal.) per flush, factory set flow, concealed quiet action, diaphragm flush and renewable seat with wheel handle angle pressure loss check stop. Unit to be supplied with metal recessed box and vandal resistant stainless steel face, measuring approximately 305 mm x 305 mm (12 in. x 12 in.) for both valve and sensor housing. Sloan Solis 8152-1.28 SWB, concealed Flushometer, or equal.
 - .4 Seat for WC unit above shall be elongated heavy-duty solid plastic toilet seat, open front with cover, with stainless steel stainless steel check hinge and stainless steel posts, washers, and nuts. Bemis 1950SS, Centoco 820STS-001, Kohler Lustra K-4650-EB, Olsonite 46SS, ZURN Z5957SS-EL.
- 2.2.6. Urinals shown as type "U-1 - Wall hung" shall be "Low Consumption", wall hung, vitreous china, wash out flush action 0.5 L (0.125 US gal.), flush, extended sides for privacy, integral flush spreader, 19 mm (¾ in.) top spud, wall hangers, open trap, removable stainless steel strainer, 50 mm (2 in.) outlet, and connecting flange with gasket and bolts. American Standard Washbrook FloWise 6590.001.020, Crane Cromwell 7398, Kohler Bardon K-4991-ER, Zurn Z5760-STR.
- .1 Automatic flush valve for urinal unit above shall be 0.5 L (0.125 US gal.), quiet action, low consumption, quiet action diaphragm flush, renewable seat, with proximity sensor, solenoid, circuitry, high pressure vacuum breaker, back-check angle stop, housed 330 mm x 430 mm (13 in. x 17 in.) in recessed metal box with 368 mm x 470 mm (14½ in. x 18½ in.) stainless steel face, located above urinal. Each unit shall be supplied with a 120/24 VAC 50 VA Transformer (5 VA power required for each unit). Delta Commercial 1600T6403ARI and 1600T6403ATR with RP32508 transformer, Sloan Optima 195-0.125 WB-ES-S with EL-154 transformer, Zurn ZEMS6195AV-OB-WS1-BX12 with P6000-HW6 Power converter.
 - .2 Exposed flush valve for urinal unit above shall be 0.5 L (0.125 US gal.), quiet action, exposed diaphragm flush, renewable seat, polished chrome plated finish, volume control, vandal resistant cover screw, metal "non hold open" handle, 1 in. FIP/copper sweat inlet adaptor angle check stop with protecting cap, adjustable 120 mm (4¾ in.)

plus or minus 11 mm (7/16 in.) inlet/valve outlet centers, vacuum breaker, 38 mm (1½ in.) dia. cover tube and wall flange, spud flange, and concealed spud nut. Delta Commercial 81T201, Sloan 186-0.125, Zurn Z6003AV-WS1.

- .3 Concealed power harvesting electronic "No Touch" flush valve unit for back spud U unit above shall be a safe 6 V system with fixed program-automatic 8 second blocking time, field adjustable flush delay setting, volume and sensing range, and manual over ride capability. Low battery alarm, 4 x AA battery backup. The flush valve shall be high efficiency 0.5 L (0.125 US gal.) per flush, factory set flow, concealed quiet action, diaphragm flush and renewable seat with wheel handle angle pressure loss check stop. Unit to be supplied with metal recessed box and vandal resistant stainless steel face, measuring approximately 305 mm x 305 mm (12 in. x 12 in.) for both valve and sensor housing. Sloan Solis 8152-1.28 SWB, concealed Flushometer, or equal.

2.3. LAVATORIES

- 2.3.1. Lavatories shown as type "L-1 – Commercial wall-mounted monolithic lavatory system. 1-4 stations, Corian or quartz construction. ADA compliant. Integrated sensor activated faucets and soap dispensers. 550mm (22") x 125mm (5") Depth x Height. Wall mounting with angle brackets or custom enclosures. Sloan DSG Splash Lab TSL.MON or equal..

- .1 Hard-wired electronic "no touch" faucet for lavatory unit above shall be a 100 mm (4 in.) centre set, solid cast brass body with integral proximity sensor, with vandal-resistant 0.5 USGPM (1.9 L) flow spray outlet, control module, solenoid, strainer, circuitry, tempered water supplied by mixing valve with back checks and stops housed in 250 mm (10 in.) Sq. recessed metal box with 300 mm (12 in.) Sq. V.P. face, located in wall under basin. Flexible conduit from control module to faucet and solenoid to be provided. Each unit shall be supplied with a 120/24 VAC 50 VA Transformer (15 VA power required for each unit). Delta Commercial 591T0258TR and ELAVT0008ARI with RP32508 transformer, Kohler K-13463/K-13478-A-CP Escutcheon with K-13480-NA power supply, Sloan ETF-600-A-VPB-MIX60-A with EL-154 transformer, Zurn Z6915-XL-CWB-F-MV-SH22-ALBOX with P6000-HW6 Power converter. Lavatories shown as type "L-2 - Wall hung (Barrier free design & general use)," tight space areas shall be 533 mm x 445 mm x 133 mm - 175 mm (21 in. x 17½ in. x 5¼ in. - 6-7/8 in.) deep, wall hung, vitreous china, rear overflow, for concealed arm support. Unit shall be provided with faucet holes to suit the faucet below. American Standard Murro 095x.000, Crane Serena 129, or Zurn Z5324-PED. Provide semi pedestal American Standard Murro 0059.020, Crane Serena 132, Kohler Pinoir K-2035 to cover exposed piping.
- .1 Faucet for lavatory unit above shall be 100 mm (4 in.) centre set, solid cast brass body with integral proximity sensor, with vandal-resistant 0.5 USGPM (1.9 L) flow spray outlet, control module, solenoid, strainer, circuitry, tempered water supplied by mixing valve with back checks and stops housed in 250 mm (10 in.) Sq. recessed metal box with 300 mm (12 in.) Sq. V.P. face, located in wall under basin. Flexible conduit from control module to faucet and solenoid to be provided. Each unit shall be supplied with a 120/24 VAC 50 VA Transformer (15 VA power required for each unit). Delta Commercial 591T0258TR and ELAVT0008ARI and RP32508 transformer, Kohler K-13463/K-13478-A-CP escutcheon with K-13480-NA power supply, Sloan ETF-600-A-VPB-MIX60-A with EL-154 transformer or Zurn Z-6915-XL-CWB-F-MV-SH22-ALBOX with P6000-HW6 Power converter. Faucet for lavatory unit above shall be single hole mount solid cast brass faucet, polished chrome plated finish, ceramic valve with high temperature rotational limit stop, vandal resistant 3½ in. (90 mm) OBC compliant metal lever handle with color index, standard spout less pop-up, and standard 0.5 USGPM (1.9 L) flow control aerator. American Standard 2000.100X.002, Delta Commercial 534LF-LPU, Zurn Z82200-XL-CP4, Kohler July K-P97282-4/K-20003 escutcheon plate.

- .3 Faucet for lavatory unit above shall be 200 mm (8 in.) centre, two handle widespread lavatory faucet, polished chrome plated finish trim, cast brass bodies, and ¼ turn ceramic disk cartridges, brass spout and trim, color indexed metal handles with vandal resistant screws, heavy duty goose neck spout less pop-up, 0.5 USGPM (1.9 L) laminar flow control moderator, and 100 mm (4 in.) OBC compliant cast brass handles. Chicago Faucet 786-FC-XK-317, Delta Commercial 27C2922, Kohler K-7303-K/K-16012-4, Zurn Z831A4-XL.
- 2.3.3. Drain for all lavatory units with exposed under counter installation shall be 32 mm (1¼ in.) size, polished chrome plated offset open grid, and cast brass lavatory waste strainer, 17 gauge tubular offset. Safety covers are to be supplied as per local codes. Delta Commercial 33T290, Kohler K-7131-A, McGuire 155WC, Zurn Z8746-PC.
- 2.3.4. Drain for all lavatory units with concealed under counter installation shall be 32 mm (1¼ in.) size, polished chrome plated inline open grid and cast brass lavatory waste strainer, 17 gauge straight tubular tailpiece. Delta Commercial 33T260, Kohler K-7129-A, McGuire 155A, Zurn Z8743-PC.
- 2.3.5. "P" trap for all lavatory units shall be polished chrome plated cast brass, adjustable body 32 mm (1¼ in.) size with cleanout plug, 17 gauge tubular wall bend. Safety covers are to be supplied as per local codes for exposed under counter installation. Delta Commercial 33T311, McGuire 8872C, Zurn Z8700-D-PC, Kohler K-8998.
- 2.3.6. Supplies for all lavatory units shall be a pair of chrome plated, heavy pattern angle lavatory supplies, lockshield, screw driver slot, stuffing box cartridge, 3/8 in. IPS brass inlet supply nipple, flexible braided stainless steel risers, and stainless steel wall flange. Delta Commercial 47T2512SD, McGuire H165LKN3RB, Zurn ZH8820-LR-LK-PC-3.
- 2.3.7. All lavatories for health care facilities shall have concealed overflows and laminar flow outlets. Modify specified trim model numbers above as required.
- 2.4. GENERAL SINK UNITS
- 2.4.1. Sinks shown as "S-1 - One Compartment Stainless Steel Sink (General use)" shall be stainless steel three hole sink, 200 mm (8 in.) centers, 520 mm x 508 mm x 203 mm (20½ in. x 20 in. x 8 in.) deep, counter mounted, back ledge, grade 18-8 type 302 stainless steel, single compartment, mirror finished rim, satin finished bowl, self-rimming with crumb cup strainer, and sound deadening. Aristaline LBS6808-1, Kindred QSL2020-8, Kohler K-3363-3 with K-8813 sink strainer, Architectural Metal Industries 1017-B-I or Novanni 1017EI.
- .1 Faucets for sink unit above shall be 200 mm (8 in.) centre, single control, brass body deckmount faucet, polished chrome plated finish, stainless steel rotating ball mechanism or ceramic disk cartridge, brass spout and trim, 200 mm (8 in.) swing spout, and 2.1 USGPM (7.9 L) vandal resistant flow aerator and vandal resistant 150 mm (6 in.) handle. American Standard 2021.600.002, Delta Commercial 100LF-HDF, Kohler K-15171-F, Zurn Z82300-XL-CP8-2M.
- 2.4.2. "P" trap for all sink units shall cast brass 38 mm (1½ in.) with union, cleanout, and escutcheon, Delta Commercial 33T360, McGuire 8912C, or Zurn Z8702BD-PC.
- 2.4.3. Supplies for all sink units shall be a pair of chrome plated, heavy pattern angle lavatory supplies, lockshield, screw driver slot, stuffing box cartridge, 3/8 in. IPS brass inlet supply nipple, flexible braided stainless steel risers, and stainless steel wall flange. Delta Commercial 47P2512SD, McGuire H165LKN5RB, Zurn ZH8820-LR-LK-PC-3.

2.5. UTILITY SINK UNITS

2.5.1. Janitor sinks shown as "JS-1 - Floor Mounted (Square Unit)" shall be 610 mm x 610 mm x 250 mm (24 in. x 24 in. x 10 in.) deep, floor mounted, precast terrazzo with integral drain and strainer. Stern-Williams MTB-2424, Acorn 242410.

- .1 Faucets for janitor sink unit above shall be 200 mm (8 in.) centers, two handle, cast brass wall mount service sink faucet, 2.1 USGPM (7.9 L), polished chrome plated finish, ¼ turn ceramic disk cartridge, rigid pail hook spout, integral stops, color indexed 70 mm (2¾ in.) metal handles with vandal resistant screws, plain spout complete with body mounted vacuum breaker, hose threaded outlet and 1220 mm (48 in.) hose and stainless steel hanger. Chicago Faucet 305-VBRXK, Delta Commercial 28C2083 with 28T911, Kohler K-8905, Zurn Z841L1-XL-SSI-HH.

3. Execution

3.1. INSTALLATION

- 3.1.1. Provide necessary plates, brackets, cleats, supports, etc., for rigidly securing fixtures in place. Accurately lay out all roughing piping, avoiding offsets.
- 3.1.2. Examine fixtures for defects. Remove and replace any fixture which, in the opinion of the Engineer's Representative, is damaged. Make necessary adjustments to ensure fixtures function as per manufacturer's operating criteria. Clean and polish all fixtures and trim upon completion.
- 3.1.3. Ensure wall-mounted fixtures with back water connections have an adjacent access door, unless the pipe space is sufficiently wide to allow the water connection to be made from within the pipe space. For this, pipe space shall be 600 mm (24 in.) minimum clear width.
- 3.1.4. Provide 120 V primary to Extra-low Voltage secondary transformers to power fixtures, as required based on fixture type. Provide cord with plug for primary side of each transformer where Electrical Drawings show receptacle(s) powering fixtures and coordinate need for cord with plug with Electrical Contractor. Install transformers and all secondary side wiring to fixtures. Where Electrical Drawings show fixtures being powered by direct connections, install so that Electrical Contractor only needs to terminate 120 V circuit at transformer.
- 3.1.5. Provide cleanouts in accordance with the requirements of Section 22 05 76.00 – CLEANOUTS.
- 3.1.6. Fixtures shall be installed symmetrical with wall tile pattern, unless otherwise dimensioned or shown on Architectural Drawings.

END OF SECTION

22 42 46.00 Fixture Carriers

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. SUBMITTALS
 - 1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.
 - 1.3. WARRANTY
 - 1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Fixtures carriers shall be Jay R. Smith, Zurn, or Mifab, or Watts.
 - 2.1.2. Carriers shall be furnished for all wall hung water closets, urinals, lavatories, service sinks and drinking fountains. Carriers shall be floor mounted and supported independently of the wall. Carriers shall be suitable for each particular fixture. Carrier feet shall not project beyond finished wall.
 - 2.1.3. All fixture carriers with integral cast iron fittings shall be certified to CSA B70 "Cast iron soil pipe, fittings, and means of joining" as required by Authority Having Jurisdiction.
 - 2.2. WATER CLOSET CARRIERS
 - 2.2.1. Carriers for water closets shown as (FILL IN LIST OF TYPES HERE) shall be as described herein. Refer to Drawings for installation arrangement.
 - 2.2.2. Carriers for water closets with single adjustable horizontal discharge shall be 100 mm (4") all coated cast iron fittings, rear anchor bolt factory assembled, face plate with rear anchor support, heavy duty legs, adjustable short cast iron nipple, plated hardware, cap nuts, test plug and protection cap. Jay R. Smith 0211Y-2-M51-95, Zurn Z1203-N(L/R)4-29, Mifab MC-10-3-6, Watts CA-101-(L/R)-M3-M12. Carriers for back to back water closets with adjustable horizontal discharge shall be 100 mm (4") all coated cast iron fittings, factory assembled face plate with heavy duty legs, adjustable short cast iron nipple, plated hardware, cap nuts, test plug and protection cap. Jay R. Smith 0211YD-2-95, Zurn Z-1203-ND4-29, Mifab MC-10D-6, Watts CA-101-D-M3. Carriers for water closets with single adjustable vertical stack discharge shall be 100 mm (4") all coated cast iron fittings, factory assembled face plate with rear anchor support, heavy duty legs, adjustable cast iron nipple, plated hardware, cap nuts, test plug and protection cap. Jay R. Smith 0230Y-2-M51-95, Zurn 1204-N4-29, Mifab MC-12-3-6, Watts CA-121-M3-M12.

- 2.2.5. Carriers for back to back water closets with adjustable vertical stack discharge shall be 100 mm (4") all coated cast iron fittings, factory assembled face plate with heavy duty legs, adjustable cast iron nipple, plated hardware, cap nuts, test plug and protection cap. Jay R. Smith 0230DY-2-95, Zurn 1204-ND4-29, Mifab MC-12D-3, Watts CA-121-D-M3-M12.
- 2.2.6. Carriers for water closets with single adjustable vertical stack discharge and offset fittings for compact installation shall be 100 mm (4") all coated cast iron fittings, factory assembled face plate with rear anchor support, heavy duty legs, adjustable cast iron nipple, plated hardware, cap nuts, test plug and protection cap. Jay R. Smith 0410(L/R)Y-2-M51-95, Zurn 1209-N(L/R)4-29, Mifab MC-15-3-6, Watts CA-151-(L/R)L-M3-M12.
- 2.2.7. Carriers for back to back water closets with adjustable vertical stack discharge and offset fittings for compact installation shall be 100 mm (4") all coated cast iron fittings, factory assembled face plate with heavy duty legs, adjustable cast iron nipple, plated hardware, cap nuts, test plug and protection cap. Jay R. Smith 0410DY-2-95, Zurn 1209-ND4-29, Mifab MC-15D-6, Watts CA-151-DL-M3.
- 2.2.8. Carriers for wheelchair use shown as shall be mounted 400 mm (16") above finished floor to rim of toilet.
- 2.3. URINAL CARRIERS
- 2.3.1. Carriers for wall hung urinals shown as (FILL IN LIST OF TYPES HERE) shall be all coated with block base feet supports and plate type system with bottom bearing plates. Jay R. Smith 637, Zurn Z-1222, Mifab M-32, Watts CA-321.
- 2.4. LAVATORY CARRIERS
- 2.4.1. Carriers for wall-hung lavatories shown as shall be all coated with rectangular steel uprights and welded block base feet support and plate. Jay R. Smith 800-M31, Zurn Z1224, Mifab MC-3, Watts CA-421.
- 2.4.2. Carriers for wall-hung lavatories shown as shall be all coated with rectangular steel uprights, welded block base feet support and concealed arms with locking device and levelling screws. Jay R. Smith 700-M31, Zurn Z1231, Mifab MC-41, Watts CA-411.
- 2.4.3. Carriers for barrier free wall-hung lavatories shown as shall be all coated with rectangular steel uprights, welded block base feet support and extended concealed arms with locking device and levelling screws. Jay R. Smith 700-27-M31, Zurn Z1231-79, Mifab MC-42, Watts CA-411-W.
- 2.5. MISCELLANEOUS CARRIERS
- 2.5.1. Carrier for clinic flushing rim service sink shown as shall be all coated factory assembled complete, with rectangular steel uprights with welded block base feet support with positioning frame 16 mm (5/8") bolts and C.P. bolt caps, 100 mm (4") 'TY' and adjustable cast iron nipple with bowl gasket. Jay R. Smith 0631Y-M31, Zurn Z1218-F4-CC, Mifab MC-62-4-V4-6, Watts CA-550-4-V4-M3.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Rigidly secure all fixture carriers to the floor using approved anchor bolts and inserts.
- 3.1.2. Verify the finished wall location and type of wall construction and elevation of finished floor before installation of carriers.

END OF SECTION

2 42 49.00 Hydrants (Plumbing Systems)

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Hydrants shall be Jay R. Smith, Zurn, Mifab, or Watts, equal to the following series.

2.1.2. Ground hydrants shall be non-freeze, key operated with 19 mm (3/4 in.) hose connection, removable nylon or bronze seat, 19 mm (3/4 in.) IPS female inlet tailpiece, brass lower valve casting and brass hydrant head enclosed in a nickel-bronze surface access box with key operated hinged cover. Depth of bury shall be 1500 mm (5 ft.). Valve shall be encased in gravel from bottom to approximately 300 mm (12 in.) below grade. Carefully determine final grade elevation before setting hydrant. Jay R. Smith 5810NB, Zurn ZN1360, Mifab MHY-60, Watts HY-500.

2.1.3. Where ground hydrants are installed in earth above lower floors of a building (i.e. courtyards above basements, areas above buried parking, etc.), the valve and drain shall project into the ceiling space below. The drain shall be piped to the closest floor drain.

2.1.4. Provide wall hydrants as follows: non-freeze, key operated with 19 mm (3/4 in.) hose connection, removable nylon or bronze seat, 19 mm (3/4 in.) ground joint union inlet, brass operating parts and nickel bronze access box with polished cover. Provide length of wall sleeve that suits location. Jay R. Smith 5509QTNB, Zurn Z1300, Mifab MHY-20, Watts HY-725.

2.1.5. Interior wall hydrant hose bibb: concealed, moderate climate, anti-siphon, narrow wall hydrant for narrow wall installation. Complete with integral vacuum breaker. Bronze head, seat casting, and internal working parts. Complete with loose key. Standard 19 mm (3/4 in.) male hose connection, 90 degree connection with 360 degree swivel with 19 mm (3/4 in.) female / 25 mm (1 in.) male threads. Adjustable nickel bronze box furnished with hinged cover, cylinder lock. WATTS HY-450.

2.1.6. All hydrants shall be complete with vandal proof vacuum breaker, if backflow preventer is not provided.

3. Execution

3.1. NOT USED

END OF SECTION

22 47 13.00 Refrigerated Drinking Fountains and Bottle Fillers

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings and/or catalogue cuts of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Type "BF-1" Drinking Fountains: Wall hung fountain with stainless steel top, light grey vinyl covered steel enclosure, safety bubbler with front and side push bar activation, laminar flow bottle filler with sensor activation, filter with visual filter status indicator, 0.37 kW (1/2 hp) refrigeration unit complete with overload protection and operating controls factory wired. Unit shall be capable of cooling 0.0084 L/s (8 USGPH) from 26.6 deg. C. (80 deg. F.) to 10 deg. C. (50 deg. F.) with 32.2 deg. C. (90 deg. F.) room ambient temperature. ADA compliant and CSA C22.2 No. 120 "Refrigeration equipment" and NSF/ANSI/CAN 61 "Drinking Water System Components - Health Effects" & 372 "Drinking Water System Components - Lead Content" certified. Elkay LZS8WSLP.

3. Execution

3.1. INSTALLATION

3.1.1. Provide necessary plates, brackets, cleats, supports, etc., for rigidly securing fixtures in place. Accurately lay out all roughing piping, avoiding offsets.

3.1.2. Examine fixtures for defects. Remove and replace any fixture which, in the opinion of the Engineer's Representative, is damaged. Make necessary adjustments to ensure fixtures function as per manufacturer's operating criteria. Clean and polish all fixtures and trim upon completion.

END OF SECTION

23 05 49.00 Seismic Force Resisting Systems

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Be responsible for all seismic resisting systems for all mechanical systems and equipment. Have one trade provide all seismic resisting systems for mechanical.

1.2. DEFINITIONS

1.2.1. Relevant Importance Category for the Building in accordance with the following codes:

.1 Ontario Building Code:

- .1 *Low*: buildings that represent a low direct or indirect hazard to human life in the event of structural failure.
- .2 *Normal*: all buildings except those listed in the Importance Categories Low, High and Post-disaster.
- .3 *High*: buildings that provide a greater degree of safety to human life than a Normal Importance Category Building, buildings that are likely to be used as post-disaster shelters, and manufacturing or storage facilities containing toxic, explosive or other hazardous substances in sufficient quantities to be dangerous to the public if released.
- .4 *Post-disaster*: buildings that are essential to the provision of services in the event of a disaster.

1.2.2. SFRS: Seismic Force Resisting System.

1.3. GENERAL DESCRIPTION

1.3.1. This section covers design, supply, and installation of complete SFRSs for all systems.

1.3.2. Fully integrate SFRS into and make compatible with noise and vibration controls in accordance with Section 20 05 48.00 - VIBRATION AND NOISE CONTROL.

1.3.3. Systems and equipment shall not be required to be operational during and after a seismic event.

1.3.4. Provide SFRS that during a seismic event prevents systems and equipment from causing personal injury and from moving from normal position.

1.3.5. Obtain the services of a Professional Engineer, licensed in the Province/Territory of the Place of the Work, and specializing in the design of SFRS, to provide the necessary design and details for a complete SFRS including system of structural supports and bracing of all mechanical equipment as required to comply with Part 4, Structural Design, of the Building Code. Require this Professional Engineer be responsible for ensuring that the installation conforms to the design.

1.4. SUBMITTALS

1.4.1. Submit Shop Drawings and Product data in accordance with Section 20 05 03.00 - SHOP DRAWINGS.

1.4.2. Include with submittals:

- .1 Full details of design criteria.
 - .2 Working drawings, materials lists, schematics, and full specifications for all components of each SFRS provided.
 - .3 Design calculations, including resisting loads resulting from seismic forces in accordance with SMACNA Seismic Restraint Manual and provincial or municipal building code.
 - .4 Separate Shop Drawings for each SFRS and devices for each system and equipment.
 - .5 Identification of location for each device.
 - .6 Schedules of types of SFRS equipment and devices.
 - .7 Details of fasteners and attachments to structure, anchorage loadings, and attachment methods.
 - .8 Installation procedures and instructions.
 - .9 Provide Shop Drawings designed and bearing the seal of a Professional Engineer licensed to practice in the appropriate discipline and in the Place of the Work.
- 1.5. WARRANTY
- 1.5.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
- 2.1. MATERIALS
- 2.1.1. Provide SFRSs from a single manufacturer and from Kinetics, Mason, or Vibro-Acoustics.
- 2.1.2. Provide positive seismic and wind resisting on those systems and components required by the Building Code and the Authority Having Jurisdiction.
- .1 Refer to Code Data Matrix on Architectural Drawings as well as the Structural Drawings for seismic design criteria values prior to bid.
 - .2 Seismic design criteria mentioned above includes: Design Spectral response acceleration for short periods, $S_a(0.2)$; Site Classification; Acceleration based site coefficient, F_a ; Importance Factor for Earthquake Loads, I_E ; and Wind reference velocity pressure, q .
- 2.1.3. Provide SFRS for piping systems that is compatible with:
- .1 Expansion, anchoring and guiding requirements.
 - .2 Equipment vibration isolation and equipment SFRS.
- 2.1.4. Do not utilize cast iron, threaded pipe, and other brittle materials as part of SFRS.
- 2.1.5. Provide seismic resisting and flexible couplings for sprinkler systems in accordance with Section 21 13 00.00 - SPRINKLER SYSTEMS, and NFPA 13.
- 2.1.6. Ensure seismic control measures do not interfere with integrity of fire stopping.
- 2.2. SFRS FOR VIBRATION ISOLATED EQUIPMENT
- 2.2.1. Equipment installed on vibration isolation requiring seismic resisting – provide in accordance with Section 20 05 48.00 - VIBRATION AND NOISE CONTROL.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install SFRS at least 25 mm (1 in.) from all other equipment, systems, and/or services.
- 3.1.2. Co-ordinate connections with all disciplines.
- 3.1.3. Install SFRS in accordance with the Seismic Professional Engineer's design.
- 3.1.4. Following the completion of the installation of the seismic resisting systems, have the designing engineer submit a stamped letter stating that the installation has been completed in accordance with the applicable Building Codes and their design. Require the engineer to complete and submit signed and sealed letters of assurance (e.g. Schedules, where applicable) and letters of compliance for all equipment that requires seismic resisting in accordance with latest codes, standards and requirements of the Authorities Having Jurisdiction.
- 3.1.5. Require engineer to include additional documentation to identify the equipment and device types and quantities that were reviewed to ensure that all components requiring seismic resisting were completed.
- 3.1.6. Require engineer to indicate in letters that "All mechanical equipment shown on the Smith and Andersen Drawings has been seismically resisted in accordance with the local Building Code."

END OF SECTION

23 05 93.13 Testing and Balancing Piping Systems

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. QUALITY ASSURANCE

1.2.1. The balancing under Section 23 05 93.23 - TESTING AND BALANCING AIR SYSTEMS and this Section shall be performed by the same balancing company.

1.2.2. Balancing companies shall be members of AABC or NEBB.

1.2.3. Acceptable balancing companies are limited to the following:

- .1 Design Test
- .2 Pro-Air Testing
- .3 VPG Associates
- .4 Airwaso
- .5 Leslie Danhart Inc.
- .6 Air Audit
- .7 Dynamic Flow Balancing Ltd.
- .8 Vital Canada Group Inc.
- .9 Verify Inc

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. NOT USED

3. Execution

3.1. GENERAL

3.1.1. Arrange for walk-through of site during project construction phase, prior to commencement of balancing, to confirm that all valves and appurtenances to fully balance and test the systems are available and accessible. Review Mechanical Contractor's proposed access door locations and sizes per Section 20 05 63.00 – ACCESS DOORS AND ACCESSIBILITY indicated on Shop Drawing and ensure that sufficient access is available.

3.1.2. A sample of a Test Verification Sheet is provided at the end of the section. Fill out this sheet or a similar one with all pertinent information for all tests called for in the Specification or required by code. Have the sheets signed by the Contractor and the Balancing Company to verify that the data recorded is correct.

- 3.1.3. Carry out leakage tests on sections of the Work and identify them by reference number on the test sheet and by description of the piping system. Indicate the reference identification number on the as-built drawings.
- 3.1.4. Test and balance the following systems:
 - .1 Refrigeration piping
 - .2 Computer Room A/C units and condensers
 - .3 Chillers and chilled water distribution
 - .4 Boilers and heating systems
 - .5 Water treatment systems
 - .6 Life safety and fire protection systems
 - .7 Plumbing systems
 - .8 Natural gas systems
 - .9 All process piping including gas, air nitrogen and vacuum
- 3.1.5. Read, fully understand and comply with all requirements of the Section 20 08 00.00 - COMMISSIONING.
- 3.1.6. Provide a schedule for all testing and balancing.
- 3.1.7. Test all plumbing systems in accordance with all applicable plumbing codes and the requirements of the authority having jurisdiction.
- 3.1.8. Test natural gas systems in accordance with CSA B149.1 "Natural gas and propane installation code".
- 3.1.9. Test all fire protection systems in accordance with all applicable NFPA codes.
- 3.1.10. Test compressed air system to a minimum of 125 % and a maximum of 150 % of pressure setting of relief valve, using nitrogen for 24 hours and ensure pressure drop does not exceed 10 % of the minimum pressure.
- 3.1.11. Test for vacuum at 1-1/2 times the operating vacuum.
- 3.1.12. For all plumbing systems over 100 psi system pressure and other systems not covered by codes noted above, test and prove tight over a period of 24 hours by a hydrostatic test. Remove vents and gauges and temporarily plug connections.
- 3.1.13. Utilize hydrostatic test pressure for steam and water systems as follows:
 - .1 1-1/2 times the system working pressure but not less than 1035 kPa (150 psig), or
 - .2 The maximum working pressure of expansion joints and vibration isolators.
- 3.1.14. Repair any leaks or defects and repeat the tests to the satisfaction of the Engineer's Representative.
- 3.1.15. On all radiant heating systems, provide a tag in accordance with Section 20 05 55.00 – VALVE TAGS AND CHARTS, securely fixed to the zone balancing valve to indicate the required flow rate. Where balancing valves are not located in the room served, also include on the tag the room(s) / area(s) served and the length of the loop.
- 3.1.16. After completion of the testing, rough balance the water systems and ensure all coils, convertors, etc., are operating to approximately design conditions to ensure freezing conditions will not occur anywhere. Adjust the circuits by means of balancing valves.
- 3.1.17. Confirm that appropriate balancing valves have been installed on all domestic hot water recirculation branch lines.

- 3.1.18. Obtain balance on water lines by inserting thermometers in thermometer wells provided for this purpose or between pipe and insulation at each balancing valve and adjusting flow until all thermometers read the same appropriate system temperature.
- 3.1.19. Co-ordinate with the balancing company to ensure all necessary valves for balancing the system are installed.
- 3.1.20. Ensure that all cooling coil drain pans drain freely and that no standing water remains.
- 3.1.21. Ensure access is provided to all valves and equipment that requires servicing.
- 3.1.22. Be responsible for all equipment operating to design conditions and trim impellers, etc., to provide the required conditions.
- 3.1.23. Correct any deficiencies in the mechanical systems which prevent balancing the system.
- 3.1.24. Do not commence insulation installation until testing report is submitted to Engineer's Representative and is reviewed by Engineer's Representative without requesting a resubmit.
- 3.1.25. Balance the entire water system to ensure all heat exchangers, etc., are operating to design conditions. Adjust the circuits by means of the balancing valves and record balance position.
- 3.1.26. Check each pump for design, working and shut-off head conditions and trim impeller on any pump that varies by more than 10 % from the design conditions until design conditions have been met.
- 3.1.27. Balance flow through all heat exchangers, chillers, boilers and other such equipment to ensure that the pressure drop through the equipment is within 10 % of the manufacturer's design conditions.
- 3.1.28. If the design conditions cannot be met by adjusting the balancing valves throughout the system, then change or trim pump impellers as required.
- 3.1.29. As part of initial balancing of coils, ensure that the pressure drops are within 10 % of the manufacturer's design conditions. When both the air and water systems are fully operational, take entering air and water and leaving air and water readings as close as possible to the peak design conditions to ensure the coil performance meets the design conditions. Only take coil water working conditions in conjunction with the air flow working conditions for the coil.
- 3.1.30. Adjust bleed-off from cooling tower, evaporative condensers, and similar equipment to prevent lime deposits. Record bleed-off rate.
- 3.1.31. Do not disconnect any control device. Furnish a list of adjusted set points. Commanding of control valves and entering of adjusted set points into the building automation system for testing and balancing purposes is performed under Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM. Co-ordinate with Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM.
- 3.1.32. Have Balancing Company witness all system tests and sign all test reports. Include one copy of all test reports in each copy of the balancing reports.
- 3.1.33. Co-ordinate to ensure that all necessary valves for control and balancing are installed in all locations required.
- 3.1.34. Be responsible for balancing the systems to obtain the design conditions, and repeat the balancing until the required conditions have been met.
- 3.1.35. At the time of final inspection, recheck in the presence of the Engineer's Representative random selections of data recorded in the certified report. Points or areas for recheck will be selected by the Engineer's Representative and be approximately 10 % of the report data.
- 3.1.36. A measured deviation of more than 10 % between the verification reading and the reported data shall be considered as failing the verification procedure.

- 3.1.37. A failure of more than 10 % of the selected verification readings shall result in rejection of the report as unacceptable.
- 3.1.38. In the event the report is rejected, rebalance all systems, submit new certified reports and make a re-inspection.
- 3.1.39. Following final acceptance of the certified reports by the Engineer's Representative, permanently mark the settings of all valves and other adjustable devices so that balance set position can be restored if disturbed at any time. For circuit balancing valves, record the valve position by the number of turns registered on the valve and lock the valve into that position. Do not mark such devices until after final acceptance.
- 3.1.40. Submit report showing the balanced temperatures at all systems.
- 3.1.41. Provide a digital copy of the final testing and balancing reports for review by the Engineer's Representative. Include copies of the final testing and balancing reports in the O&M Manuals. Ensure reports are complete with index pages and index tabs, and are certified by the Balancing Company. Prepare all diagrams as single line representation of a Mechanical system specifically prepared for this Project using a CAD system acceptable to Engineer's Representative.

TEST VERIFICATION SHEET - PIPING

Test Number: Date:

System:

Description and sketch of tested component

Starting test pressure Starting test temperature

Final test pressure Finish test temperature

Duration of test

Test performed by: (signature)

(Printed name)

(Company)

Test witnessed by: (signature)

(Printed name)

(Company)

Verified by: (signature)

(Printed name)

(Company)

Test witnessed by: (signature)

(Printed name)

(Company)

END OF SECTION

23 05 93.23 Testing and Balancing Air Systems

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. QUALITY ASSURANCE

1.2.1. The balancing under Section 23 05 93.13 - TESTING AND BALANCING PIPING SYSTEMS and this Section shall be performed by the same balancing company.

1.2.2. Balancing companies shall be members of AABC or NEBB.

1.2.3. Acceptable balancing companies are limited to the following:

- .1 Design Test
- .2 Pro-Air Testing Inc.
- .3 VPG Associates
- .4 Airwaso
- .5 Leslie Danhart Inc.
- .6 Air Audit
- .7 Dynamic Flow Balancing Ltd.
- .8 Vital Canada Group Inc.
- .9 Verify Inc.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. NOT USED

3. Execution

3.1. GENERAL

3.1.1. Arrange for walk-through of site during project construction phase, prior to commencement of balancing, to confirm that all dampers and balancing devices to fully balance and test the systems are available and accessible. Review Mechanical Contractor's proposed access door locations and sizes per Section 20 05 63.00 – ACCESS DOORS AND ACCESSIBILITY indicated on Shop Drawing and ensure that sufficient access is available.

3.1.2. A sample of a Test Verification Sheet is provided at the end of the Section. Fill out this sheet or a similar one with all pertinent information for all tests called for in the Specification or required by code. Have the sheets signed by the Contractor and the Balancing Company to verify that the data recorded is correct.

- 3.1.3. Carry out leakage tests on Sections of the Work and identify these Sections by reference number on the test sheet and by description of the duct system. Indicate the reference identification number on the as-built drawings.
- 3.1.4. Test and balance the following systems:
- .1 Computer Room A/C Units
 - .2 Air conditioning, ventilation and heating systems
 - .3 Miscellaneous ventilation or exhaust systems
 - .4 Life safety systems
 - .5 Air distribution (supply, return and exhaust)
 - .6 Miscellaneous systems on emergency power
 - .7 Heat pumps
- 3.1.5. Read, fully understand and comply with all requirements of the Section 20 08 00.00 - COMMISSIONING.
- 3.1.6. Provide a schedule for all testing and balancing.
- 3.1.7. Duct Pressure Tests
- .1 Perform pressure tests before ductwork is concealed or insulated.
 - .2 Follow SMACNA HVAC Air Duct Leakage Test Manual procedures.
 - .3 Provide blower and all test equipment.
 - .4 Test the percentage of ductwork indicated in the table below. If a test specimen fails to meet the specified air leakage criteria, modify fabrication methods to bring it into compliance and retest until acceptable duct air leakage is demonstrated. If pressure test fails any sample twice, increase percentage of ductwork tested as indicated in the rightmost column of the table below.
 - .5 Include as a minimum, 5 transverse joints, typical seams, an access door, 2 branch connections and 1 elbow in test samples.
 - .6 Ensure leakage amount does not exceed the allotted amount in the table below for the duct construction pressure class in question.
 - .7 Seal any leaks causing noise.
 - .8 Leakage Class:
- | Duct Construction Pressure Class | Rectangular Leakage Class | Round Leakage Class | Amount of Ductwork to be Tested | Percentage of Ductwork to be Tested if Test Fails any Sample Twice |
|----------------------------------|---------------------------|---------------------|---------------------------------|--|
| 10 in. w.g. | 4 | 2 | 100 % | N/A |
| 6 in. w.g. | 4 | 2 | 100 % | N/A |
| 4 in. w.g. | 4 | 2 | 25 % | 50 % |
| 3 in. w.g. | 8 | 4 | 25 % | 50 % |
| 1/2, 1, and 2 in. w.g. | 16 | 8 | 10 % | 20 % |
- .9 Submit testing report, including leakage calculations, as a submittal complying with the requirements of Section 20 05 03.00 – SHOP DRAWINGS.
- 3.1.8. Do not commence insulation installation until testing report is submitted to Engineer's Representative and is reviewed by Engineer's Representative without requesting a resubmit.

- 3.1.9. Refer to Section 23 31 13.00 - DUCTWORK AND SPECIALTIES for pressure ratings of ductwork and systems.
- 3.1.10. Test HEPA filter housings by pressure decay (ANSI/ASME N510) and ensure leakage does not exceed 0.2 % duct volume/minute at 2500 Pa (10 in. W.G.).
- 3.1.11. Test the entire system for noise, tightness of joints and proper functioning of the system. Make noise tests under minimum system pressure drop conditions (highest air velocities and clean filter conditions). Make all necessary alterations and repeat the tests until satisfactory operation is achieved.
- 3.1.12. Adjust minimum outside air controller and adjust return air and exhaust air damper linkages to approximately design air quantities, for both maximum and minimum conditions where required, to ensure freezing conditions will not occur.
- 3.1.13. Ensure all necessary manual dampers for balancing the systems are installed.
- 3.1.14. Itemize the testing equipment in the test reports. Ensure calibration of the test equipment is current before any tests are undertaken and document calibration dates in test reports.
- 3.1.15. Be responsible for all equipment operating to design conditions and change fan sheaves, etc., to provide the required conditions.
- 3.1.16. Install new filters for the measuring and balancing process. Provide filters in accordance with Section 23 41 16.00 - DISPOSABLE FILTERS or as noted in the relevant air handling system Specifications and schedules.
- 3.1.17. Ensure that all necessary manual dampers for balancing are installed in all locations required.
- 3.1.18. Balance the entire air systems including air volumes and control settings under maximum system pressure drop conditions (filter at replacement condition).
- 3.1.19. Measure, make final adjustments and report upon: the air volume at each variable volume box, diffuser, register and grille; the air quantity handled by each fan; the static pressure upstream and downstream of the fan; the fan speed; and the motor current.
- 3.1.20. Report upon the air flow at outside, return and exhaust air dampers under conditions of minimum outside air, for maximum and minimum volumes and maximum outside air, exhaust air and return air.
- 3.1.21. Only take coil working conditions in conjunction with the fluid flow working conditions for the coil.
- 3.1.22. Ensure air volumes measured are within plus or minus 5 % of those shown on Drawings for diffusers, grilles, registers, variable air volume boxes and fans, at both maximum and minimum volumes shown.
 - .1 Take duct traverse readings through the access ports provided. Where no access ports have been provided, make new holes as required. Reseal these holes after final readings with sheet metal cover plates and sealant. Duct tape is not acceptable.
 - .2 Where insulation is damaged, repair it including the vapour barrier in an approved manner. Duct tape is not acceptable.
- 3.1.23. Do not disconnect any control device. Command control devices and enter adjusted set points into the building automation system with tools and training that are furnished under Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM.
- 3.1.24. In all cases where measurements show failure to comply with the Drawings and Specifications, change fan sheaves, etc., as required, and make new balancing measurements.
- 3.1.25. Ensure all thermostats and controls are set to give specified conditions and include settings in report.

- 3.1.26. For additional information on variable volume boxes, refer to Section 23 36 16.00 - VARIABLE VOLUME BOXES.
- 3.1.27. Witness all system tests and sign all test reports. Include one copy of all test reports in each copy of the balancing reports.
- 3.1.28. Set up fans on all systems to give the minimum discharge pressure required to overcome the resistance of the box, discharge ductwork and diffusers.
- 3.1.29. Be responsible for balancing the systems to obtain the design conditions and repeat the balancing until the required conditions have been met.
- 3.1.30. At the time of final inspection, recheck in the presence of the Engineer's Representative random selections of air quantities and fan data recorded in the certified report. Points or areas for recheck shall be selected by the Engineer's Representative and be approximately 10 % of the report data.
- 3.1.31. At the time of verification, measure space temperature and humidity in a representative number of rooms to verify performance. Tabulate these results and bind into certified report as an appendix.
 - .1 A measured flow deviation of more than 10 % between the verification reading and the reported data shall be considered as failing the verification procedure.
 - .2 A failure of more than 10 % of the selected verification readings shall result in rejection of the report as unacceptable.
 - .3 In the event the report is rejected, rebalance all systems, submit new certified reports and make a reinspection, all at no additional cost to the Owner.
- 3.1.32. Following final acceptance of the certified reports by the Engineer's Representative, permanently mark the settings of all valves, dampers, and other adjustable devices so that balance set position can be restored if disturbed at any time. Do not mark such devices until after final acceptance.
- 3.1.33. Provide a digital copy of the final testing and balancing reports for review by the Engineer's Representative. Include 3 copies of the final testing and balancing reports in the O&M Manual. Ensure reports are complete with index pages and index tabs. Prepare any diagram as single line representation of a Mechanical System specifically prepared for this Project using a CAD system acceptable to the Engineer's Representative.
 - .1 Submit a sample to the Engineer's Representative for review.

TEST VERIFICATION SHEET - DUCTWORK

Test Number:

Date:

System:

Description and sketch of tested component

Test pressure Surface area of ductwork under test

Duct Leakage (cfm) Allowable duct leakage (cfm)

Duration of test

Test performed by: (signature)

Verified by: (signature)

(Printed name)

(Printed name)

(Company)

(Company)

Test witnessed by: (signature)

Test witnessed by: (signature)

(Printed name)

(Printed name)

(Company)

(Company)

END OF SECTION

23 09 00.00 Building Automation System (BAS)

1. General

1.1. WORK INCLUDED

- 1.1.1. Provide all labour, materials, Products, equipment and services to supply, install, test and commission new additions and integrate into existing Building Automation System (BAS) with Direct Digital Control (DDC) for building mechanical and electrical systems as indicated on Drawings and described herein.
- 1.1.2. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.3. Conform to Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS.
- 1.1.4. Conform to Section 23 31 13.00 - DUCTWORK AND SPECIALTIES.
- 1.1.5. Conform to Section 23 35 16.00 - ELECTRIC POWER GENERATOR.

1.2. RELATED SECTIONS

- 1.2.1. Section 01 60 00.00 - BASIC PRODUCT REQUIREMENTS.
- 1.2.2. Section 20 05 14.00 - WIRING AND STARTERS.
- 1.2.3. Section 20 05 63.00 - ACCESS DOORS AND ACCESSIBILITY.
- 1.2.4. Section 20 08 00.00 - COMMISSIONING.
- 1.2.5. Section 26 05 01.00 - ELECTRICAL GENERAL REQUIREMENTS.
- 1.2.6. Section 27 00 05.10 – GENERAL INSTRUCTIONS FOR COMMUNICATION SECTIONS

1.3. PROJECT SCOPE PHASE 1

- 1.3.1. Install new network riser for BAS and future connection of other building systems. Ensure network allows for Rapid Spanning Tree Protocol (RTSP)
- 1.3.2. Input/output wiring, if it is installed per this Specification, can be reused.
- 1.3.3. Install new controls for all floor unitary equipment and connect to the BAS.

1.4. SYSTEM OUTLINE

1.4.1. General

- .1 The intent of this specification is to provide a system that is consistent with BMS systems throughout the owner's facilities running the Niagara 4 Framework.
- .2 The documentation contained in this section and other Contract Documents pertaining to Building Automation System (BAS) is schematic in nature. The Contractor shall provide all required hardware and software necessary to implement the functions shown or implied in the Contract Documents.
- .3 System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, BACnet™, LonTalk, KNX, and Modbus
- .4 System shall be capable of data export via native MQTT.

- .5 System architecture shall provide secure Web access using any of the current versions of Microsoft Internet Explorer, Mozilla Firefox, or Google Chrome browsers from any computer on the owner's LAN.
- .6 Control system to consist of high-speed, peer-to-peer network of microprocessor based DDC controllers and web-based operator interface.
- .7 Control system to consist of microprocessor based DDC controllers.
- .8 DDC controllers shall be based on open type protocols, BACnet as defined by ANSI/ASHRAE standard 135-2012 for potential future connection to Building Automation System (BAS).
- .9 Control system to consist of high-speed, peer-to-peer network of microprocessor based DDC controllers and integrate with existing BAS.
- .10 Each system, building floor plan and control device shall be displayed through point-and-click graphics.
- .11 Owner shall receive all Administrator level login and passwords for engineering toolset at first training session. The Owner shall have full licensing and full access rights for all network management, operating system server, passwords, engineering and programming software required for the ongoing maintenance and operation of the BMS.
- .12 BAS shall provide support for smart phones & portable devices via one or more of the current common standards: Apple iOS (iPhone, iPad), Android Open Source Project (Android devices), Windows Mobile Devices.
- .13 BAS to operate on building LAN communication infrastructure.
- .14 The intent of this Specification is to provide a system that is consistent with BMS systems throughout the Owner's facilities running the Niagara Framework. Any control vendor that shall provide additional BMS server software shall be unacceptable. Only systems that utilize the Niagara Framework shall satisfy the requirements of this section.
- .15 All control devices furnished with this Section shall be programmable directly from the Niagara Framework embedded toolset upon completion of this Project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.
- .16 Any control vendor that shall provide additional BMS server software shall be unacceptable. Only systems that utilize Niagara 4 Framework shall satisfy the requirements of this section.
- .17 OPEN NIC STATEMENTS - All Niagara software licenses shall have the following NiCS: "accept.station.in=*"; "accept.station.out=*"and "accept.wb.in=*"and "accept.wb.out=*". All open NIC statements shall follow Niagara Open NIC specifications.
- .18 Connect existing BAS to new BAS

1.4.2. Functional Principals

- .1 BAS to control mechanical and electrical equipment as specified in CONTROL SEQUENCES, SCHEMATICS AND EQUIPMENT SCHEDULES.
- .2 Controls to control mechanical and electrical equipment as specified in CONTROL SEQUENCES
- .3 System architecture to be modular permitting expansion of application software, system peripherals and field hardware.

- .4 Each controller to operate independently by performing its own specified control, alarm management, operator I/O and historical data collection receiving information from input field devices and controlling output field devices to perform the control sequences.
 - .5 DDC controller may control more than one system provided that points associated with those systems are connected to that same controller.
 - .6 DDC controllers to be configured so that main inputs and outputs from any control loop are located in that same controller.
 - .7 Global points used for control loop reset such as outdoor air temperature are exempt from this requirement.
 - .8 DDC controllers to be capable of operating with local closed loop programming, independent from the server if communication is interrupted.
 - .9 Where PID control loops are called for in the sequences, they are to be implemented within the controller.
 - .10 BAS server shall perform global control programs and data consolidation and storage, communicating and obtaining data from all controllers and transmitting instructions to all controllers.
 - .11 The supplied system must incorporate the ability to access all data including graphics, reports and alarm detection using standard Web Browsers without requiring proprietary operator interface and configuration programs. An Open Data Base Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a Supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable
 - .12 Support for the exchange of Comma-Separated Value (CSV) files must be provided.
- 1.4.3. Mechanical Contractor to carry the cost of Controls Contractor.

1.5. BASE BUILDING BAS PROVIDER

1.5.1. Approved Suppliers And Manufacturers

Supplier	Manufacturer Product Line	Address/ Location	Contact
HTS Engineering Limited	Distech	115 Norfinch Drive, Toronto, ON M3N-1W8	Steven Davis P: (416) 661-3400 Fax: (416) 661-0100E: steve.davis@hts.com
Modern Niagara	Distech	8125 Hwy 50 Vaughan, ON L4H 4S6	Mark Paolozzi t: 416-749-6031 m: 416-771-2639 MPaolozzi@modernniagara.com lbTEstimating@modernniagara.com
Convergint	Webs Schneider	15 Marmac Dr Suite 100, Etobicoke ON M9W 1E7	Steven Chadwick O : 905-6028622 M : 905-9299015 E : Steven.chadwick@convergint.com

Supplier	Manufacturer Product Line	Address/ Location	Contact
		360 Elgin St. Brantford, On N5Z 2V1	Devin Cousineau Phone: 519-281-9132 Email: devin.cousineau@convergint.com
Voyager Buildings	Optimizer Advance Controller Suite	5800 Ambler Dr. Unit #210, Mississauga, ON L4W 4J4	Abhishek Khurana (905) 808-9505 akhurana@voyagerbuildings.com
Automated Controls & Energy Solutions Group	Optimizer Advance Controller Suite	5285 Solar Dr Unit 103, Mississauga, ON L4W 5B8	Gezim Berisha Tel: (289) 622 - 9998 Ext: 105 gberisha@acesolutionsgroup.ca
Advanced Energy Management Ltd.	Optimizer Advance Controller Suite	466 Morden Rd, Oakville, ON, L6K 3W4	Braedon Gunovski Mobile (647-326-3336) Email: bgunovski@aemltd.com

1.6. OPEN PROTOCOL STANDARD

- 1.6.1. Intention of this Specification is to provide an integrated, open protocol BAS, BACnet as defined by ANSI/ASHRAE Standard 135.
- 1.6.2. BACnet devices on the lower tier network to support all BACnet functional groups, standard application services and standard object types necessary, but not limited to provide reading and writing functionality of all analog and binary inputs and outputs and change-of-value initiation and reporting between BACnet devices on the network.
- 1.6.3. All BACnet devices to be BTL tested. Provide Protocol Implementation Conformance Statement (PICS) for all BACnet devices.

1.7. SYSTEM COMMUNICATION ARCHITECTURE

- 1.7.1. New Riser is to be installed for the BAS. Ensure riser allows for Rapid Spanning Tree Protocol (RTSP)The first tier of the BAS network shall be based on Ethernet (ISO 8802-3/IEEE 802-3) communications, providing a high-speed local area network for reliable peer-to-peer communications. Future connected systems shall have compatibility specifications to provide communication with the first tier LAN. The operator workstations shall also be supported on the high speed LAN Tier 1. Communication speed on first tier network shall be at rate of 10 Mbps or higher.
- 1.7.3. Tier 1 to be integrated into the IP Network. Coordinate with the Owner and communication service provider for required number of IP addresses, required number and location of Ethernet ports and subnets; identification of Internet socket port number requirements for external communication through Owner firewall.
- 1.7.4. Typical office floors field controllers, including but not limited to VAV, CAV, FCU, etc., shall be set up in a Daisy Chain configuration. Typical floor network shall not traverse floors.

- .2 If floor field controllers are IP-based and daisy-chained, the network shall be looped back around to the network switch from the last controller, in addition to a network connection at the first controller of the loop. As a result, the Field controllers in the loop will have 2 connections to the network switch for redundancy.
- 1.7.5. The BAS Contractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using Ethernet and TCP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.
- 1.7.6. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Windows operating systems.
- 1.7.7. DDC controllers shall have communication port for temporary connection to laptop computer or operator interface device to allow downloads, uploads and other commissioning and troubleshooting operations.
- 1.8. EQUIPMENT SUPPLIED FOR INSTALLATION UNDER OTHER SECTIONS
- 1.8.1. Automatic control valves except otherwise noted.
- 1.8.2. Temperature sensor wells.
- 1.8.3. Terminal unit controllers including transformers. Ship to terminal unit manufacturer's facility for factory installation.
- 1.8.4. Motorized Dampers except otherwise noted. Verify damper sizes and connection type with Sheet Metal Contractor prior to ordering.
- 1.8.5. Dampers except otherwise noted. Verify damper sizes and connection type with Sheet Metal Contractor prior to ordering.
- 1.9. BAS PERFORMANCE
- 1.9.1. Graphic Display: Display the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in ten seconds.
- 1.9.2. Graphic Refresh: Update the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in ten seconds.
- 1.9.3. Data Scan: Update point object data at controllers and Operator Interfaces with current point object data at a minimum rate of once every ten seconds.
- 1.9.4. Binary Object Command: Controlled device will react within five seconds of an operator initiated command on a binary point object.
- 1.9.5. Analog Object Command: Controlled device will start to react within five seconds of an operator initiated command on an analog point object.
- 1.9.6. Alarmed Object Display: Alarm will annunciate visually and audibly at Operator Interfaces within five seconds on local area networks and within forty-five seconds on wide-area networks from the time the object entered the alarmed state.
- 1.9.7. Program Execution Rate: Provide ability to execute programs at a minimum rate of once every five seconds. Provide execution rates suitable for processes controlled.

- 1.9.8. PID Execution Rate: Provide adjustable execution rates for proportional-integral-derivative (PID) loops; update the controlled variable and command the controlled device at this same rate. Provide execution rates suitable for processes controlled.
- 1.9.9. Display and Report Accuracy: Provide minimum accuracy for point object data displayed at Operator Interfaces, reported to printers, reported to data files to Table 1: Display and Report Accuracy.

Table 1: Display and Report Accuracy.	
Point Object	Accuracy
Room Air Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual
Duct Air Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual
Outside Air Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual
Dew Point Temperature	+/-1.5 deg. C (+/-2.7 deg. F) from actual
Water Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual
Relative Humidity	+/-2 % of actual for 20% to 80% RH at 25 deg. C (77 deg.F)
Water Flow	+/-1.2 % of actual for 3.0 to 30.0 ft/s
Air Flow, Terminal Unit	+/-5.0 % of actual
Air Flow, Fan Bell and Duct	+/-5.0 % of actual
Air Flow, Pressurized Space	+/-3.0 % of actual
Air Pressure, Duct	+/-0.45 % of scale length
Air Pressure, Room	+/-0.45 % of scale length
Fluid Pressure (other than air)	+/-0.45 % of scale length (see Note 1)
Electrical (current, voltage, power)	+/-1.2 % of actual (see Note 2)
Carbon Monoxide	+/-3.2 % of actual
Carbon Dioxide	+/-3.2 % of actual
Note 1: For both absolute and differential pressure.	
Note 2: Does not include utility grade meters.	

- 1.9.10. Control Tolerance: Maintain controlled variable to control tolerance from set point to Table 2: Control Tolerance.

Table 2: Control Tolerance.		
Controlled Variable	Range	Control Tolerance from Set Point
Room Temperature		+/-0.6 deg. C (+/-1.1 deg. F)
Duct Temperature		+/-0.6 deg. C (+/-1.1 deg. F)
Humidity		+/-5 % RH
Air Flow		+/-1.0 % of scale length
Air Pressure	0-1500 Pa (0-6 in. w.g.)	+/-1.0 % of scale length

	-25 to 25 Pa (-0.1 to 0.1 in. w.g.)	+/- 10.0 % of scale length
Fluid Pressure (other than air)		+/- 1.0 % of scale length

1.10. SUBMITTALS

1.10.1. Product Data and Shop Drawings:

- .1 Within 30 days of award of contract, before start of construction, submit completely engineered and coordinated shop drawing package.
- .2 Before start of construction, submit completely engineered and coordinated shop drawing package including graphics samples
- .3 Submittals in printed format and as amended below.
- .4 Provide drawing files through Email to Client and S+A Representative.
- .5 Riser Diagrams: Indicate: communication wire paths and connections to network devices; power wire and ground wire connections to Operator Interfaces and network devices; wire types and port types with manufacturer's model numbers; communication protocol and communication speed for network segments; power panel and breaker designations; wire terminal designations; addresses for network devices; room designations.
- .6 Specifications and Instructions: Indicate: dimensions, capacities, electrical characteristics, mechanical characteristics, environmental characteristics, performance characteristics, finishes. Circle model number for Products provided or furnished. General catalogue sheets are not acceptable. Provide installation instructions.
- .7 System Flow Diagrams: Indicate: control devices, control device designation, control device range, control device fail-safe position, point object type, point object name, point object address. Indicate flow directions for gases and liquids relevant to the controlled process. Indicate hardwired interlocks between control devices and equipment. Indicate the location of field control devices.
- .8 Products Schedule: Indicate: Product designation, Product name, Product manufacturer, Product model number, Product data sheet reference number, quantities. Provide quantities required under the Work.
- .9 Valve Schedule: Indicate: system designation, service, medium, quantity, reference drawing, valve type, pipe configuration, fail position, pipe size, valve body size, valve design flow, valve design pressure drop, actual valve pressure drop, design Cv, valve Cv, design close-off, valve close-off, control type, control signal, connection type, valve model number.
- .10 Damper Schedule: Indicate: system designation, control device designation, duct dimensions, blade width, blade type, damper model number, calculated torque, actuator torque, actuator model number, actuator quantity, actuator fail-safe position, provisions for edge and blade seals and actuator mounting configuration.
- .11 Room Schedule: Indicate: controller object name, controller address, controller model number, application designation, room designation, VAV air volume set points, and sensor model numbers.
- .12 Cabinet Layouts: Interior: Indicate: orientation of contents including controllers, transformers, cable trays, terminal strips, relays, control devices, labels. Exterior: Indicate: orientation of gauges, displays, switches, labels.

- .13 Wire Details: Indicate: connections between control devices, controllers and equipment; connections to sources of power and grounds; control device designations, control device terminal designations, control device location; equipment terminal designations; cabinet terminal strip designations; wire designations. For control devices shown on multiple Drawings, indicate the control device with the same designation on all Drawings. Differentiate between manufacturer installed wire and field installed wire.
 - .14 Sequence of Operation: Provide a complete description of operation to Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS. Provide description of operation for interlocks that directly connect to the Work. Indicate references to the system flow diagram by control device designation or point object name.
 - .15 Custom Application Programs (Algorithms): Provide in printed format to Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS. Provide comments that describe the details of program functions.
 - .16 Flow Diagrams for Custom Application Programs (Algorithms): Provide in printed format to Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS.
 - .17 Points Schedule: Indicate: input points, output points and virtual points for each controller. Indicate: point object address, point object name, point object description, point object alarm limits. List points in ascending order based on point object address.
 - .18 Submit floor plan drawing indicating the coverage of Thermostats sensors where applicable or a spreadsheet to convey the same information.
- 1.10.2. Samples:
- .1 Provide with submittal under Part 1: Product Data and Shop Drawings for approval by the Owner and/or Consultant:
 - .1 Graphic Representations: Conceptual layouts in printed format of images and point objects for systems under Part 3: Execution, Operator Interface. Indicate or explain which other graphic representations are directly accessed.
 - .1 Typical terminal unit floor plan graphic that shows conditions on occupied floor.
 - .2 Typical equipment room floor graphic.
 - .3 Typical graphic for each system and terminal unit.
 - .4 Typical navigation menu.
 - .5 One sample graphic for each equipment type.
 - .6 One sample graphic for chilled water system.
 - .7 One sample graphic for hot water system.
 - .2 Test Forms: In printed format for test forms under Part 3: Execution, Testing and Commissioning.
 - .3 Products: As specified under Part 3: Execution, Control Devices.
- 1.10.3. Work Schedule:
- .1 Provide a schedule of the Work within four weeks of contract award. Indicate: intended sequence of tasks, start dates, task durations, and delivery dates for material and equipment requiring long lead times, restraints on Work by other trades or situations.
 - .2 Provide monthly updated Work Schedule indicating percentage complete and revisions to expected delivery dates.
- 1.10.4. Values Schedule:

- .1 Provide a schedule of separate system prices that comprises the price of the Work of this Section within four weeks of contract award. In addition to the system price, indicate material and labour prices separately for the system. Indicate each mechanical and electrical system as a separate price. Indicate terminal unit systems of the same type on a floor as a separate system price for the respective floor. Include the price for communication networks and power networks allocated proportionately to the separate system prices. Indicate the Operator Interfaces as a separate system price. Include all costs associated with the Work of the system in the separate system price.
 - .2 The Values Schedule provides the basis for progress payments.
- 1.10.5. Project as-built documents:
- .1 Operation and Maintenance Manuals:
 - .1 Provide two copies in printed format for review by the Consultant at least ten weeks before the projected Substantial Completion date.
 - .2 Provide 2 copies of corrected manuals in printed format and three copies on Email to Client and S+A Representative within three weeks following completion of Acceptance Test under Part 3: Execution. Provide manuals in hard cover three-ring binders with index page and indexing tab per section.
 - .3 Sections:
 - .1 Contact Information: Provide names, addresses, 24-hour telephone numbers of service representatives and installing Subcontractors.
 - .2 Operation: Provide Owner operating manuals for Operator Interfaces, Controller Resident Software, DDC Controllers, Advanced Application Controllers, Specific Application Controllers, control devices, compressed air system. For Custom Application Programs (Algorithms) Editor, provide a reference manual for the language syntax that describes each function.
 - .3 Engineering, Installation and Maintenance: Provide manuals for design and installation of point objects, controllers, and control devices. Provide instructions for calibrating, troubleshooting and replacing controllers and control devices.
 - .4 Software: Provide complete original issue media and release notes for Operator Interfaces.
 - .5 Preventive Maintenance Procedures: Provide for Operator Interfaces, controllers, control devices. Provide a schedule of tasks; indicate dates for inspection, maintenance and calibration; indicate the pages in the engineering, installation and maintenance manuals that list the procedures.
 - .6 Replacement Parts List: Indicate: manufacturer name, manufacturer model number, Supplier name, Supplier address, Supplier telephone number.
 - .7 Certificates: Provide original issue certificates for installation, maintenance and calibration.
 - .8 Test Forms: Provide copies of test forms completed under Part 3: Execution, Testing and Commissioning.
 - .9 Provide certificate of pressure test under Part 3: Execution, Control Air Tubing.
 - .10 Provide licenses, guarantees and warranty documents for Products and systems.
 - .2 As-built Product data and Shop Drawings:

- .1 Provide drawing files through Email to Client and S+A Representative.
 - .2 Points Schedule: For points schedule generated under Part 1: Submittals, Product Data and Shop Drawings, indicate operating conditions for point object data; list point objects by system designation and alphabetically by point object name.
 - .3 Time-of-Day (TOD) Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.
 - .3 As-built floor plans:
 - .1 Maintain on the Project site as-built conditions on one full-size set of Contract Drawings, referred to as marked-up drawings; indicate on these drawings as-built locations for: control devices, cabinets, network devices with network address, communication networks by type and address, connection points to communication networks for Operator Interfaces, power networks, conduit paths, junction boxes, Operator Interfaces.
 - .2 Submit three copies of marked-up drawings to Consultant for review within three weeks following successful completion of Acceptance Test under Part 3: Execution. Revise Contract Drawings to match the approved marked-up drawings; revise using AUTOCAD Release 12 or higher format and submit three copies as full-size in printed format and two copies electronically in a means discussed in as-built product data and Shop Drawings.
 - .4 Software Backup:
 - .1 Provide with as-built Product data and Shop Drawings.
 - .2 Provide three copies of complete BAS databases on Email to Client and S+A Representative.
 - .5 Training Manuals:
 - .1 Provide a course outline, and one copy in printed format of training manuals provided under Part 3: Execution, Instruction and Training at least six weeks prior to the first class. Modify the course outline and training materials to suit Owner's requirements and as requested by the Consultant.
- 1.11. WARRANTY
- 1.11.1. Warrant the Work free from defects in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and as amended below.
- 1.11.2. Adjust, repair or replace defects and failures in the Work at no additional cost during the warranty period and without reduction in service to the Owner. Provide warranty service during normal business hours and within 24 hours of the Owner's request for service.
- 1.11.3. Provide warranty service by factory trained service representatives of the Supplier.
- 1.11.4. Replace Operator Interface software, Controller Resident Software, controller firmware and database files with revisions that correct deficiencies or defects during the warranty period at no charge to the Owner. Notify the Owner of changes and schedule the installation. Update Operation and Maintenance Manuals with firmware release notes.
- 1.11.5. Prior to testing date under Part 3: Execution, Acceptance Test, update firmware in controllers to latest revisions at no additional cost to the Owner; update Operation and Maintenance Manuals with firmware release notes.
- 1.11.6. During the warranty period check the tuning of each control loop once during heating season and once during cooling season; notify the Owner when this Work is to occur. Forward to the Consultant documentation indicating observations and adjustments made.

- 1.11.7. Warrant Products that are reconditioned under the Work to the same requirements as new Products.
- 2. Products
 - 2.1. MATERIALS
 - 2.1.1. Existing Products: To Part 3: Execution, Existing Products.
 - 2.1.2. New Products: Non-beta versions currently under manufacture and have been applied in similar installations for a minimum period of one year.
 - 2.1.3. Revisions: Latest available revision for Operator Software, Controller Resident Software and controller firmware at start of Warranty.
 - 2.1.4. Revisions: Latest available revision for Controller Resident Software and controller firmware at start of Warranty.
 - 2.1.5. Replacement Parts: Readily available and not scheduled for discontinuation at time of Total Project Completion.
 - 2.1.6. Expansion: Expandable through additional inputs and outputs and to card access, security, fire alarm, lighting control systems and other building systems.
 - 2.2. NETWORK
 - 2.3. BAS
 - 2.3.1. The Tier 1 network shall have the following minimum capabilities:
 - .1 The communication protocols utilized for peer-to-peer communications in Tier 1 will be BACnet IP. Use of a proprietary communication protocol for peer-to-peer communications in any Tier is not allowed.
 - .2 High speed data transfer for alarm reporting, point log reporting and uploading/downloading of programs.
 - .3 Single or multiple node failure reporting.
 - .4 Message and alarm buffering to prevent data loss.
 - .5 Rapid Spanning Tree Protocol (RTSP)
 - .6 Error detection, correction and re-transmission to ensure data integrity.
 - .7 Synchronization of the real time clocks in the Building Controllers and Advanced Application Controllers.
 - .8 Employ a device count capacity license model that supports expansion capabilities.
 - .9 Shall be enabled to support and shall be licensed with the following Open protocol drivers (client and server) by default:
 - .1 BACnet, MODBUS
 - 2.3.2. Provide a network that exceed the following capabilities:
 - .3 Data transfer rate of at least 10 Mbit/s for alarm reporting, point log reporting and uploading/downloading of programs.
 - .4 Single or multiple node failure reporting.
 - .5 Error detection, correction and re-transmission to ensure data integrity.

- .6 Synchronization of the real time clocks in the Building Controllers and Advanced Application Controllers.
- 2.3.3. Message and alarm buffering to prevent data loss shall be provided within the IP controllers.
- 2.3.4. Coordinate with base building local area network provider to ensure connectivity of all BAS devices and allocation of network ports.
- 2.3.5. A failure of any component or controller on the base building local area network shall not interrupt the execution of communication on this network.
- 2.3.6. Provide full communication capability across all systems including the base building local area network so that all BAS specified downloading, uploading, data transmission, control commanding, alarm handling and programming is achieved smoothly and transparently.
- 2.3.7. Review location and quantity of communication hub ports required for connection of lower tier networks to the Tier 1 network. Coordinate and arrange use of ports with Base Building Local Area Network Contractor.
- 2.3.8. BAS Network shall have an extra 25 % capacity for future expansion on all tiers.
- 2.3.9. Remote Network Access: For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.
- 2.3.10. Remote Network Access: For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet.
- 2.4. CENTRAL SERVER
- 2.4.1. Provide industry standard hardware that meets or exceeds DDC System manufacturer recommended specifications and that can achieve response times required by Specification Section 1.11 BAS PERFORMANCE.
- 2.4.2. Minimum Computer Configuration (Hardware Independent).
 - .1 Central Server. Owner shall provide a dedicated BAS server with configuration that includes the following components as a minimum:
 - .2 Processor: Intel® Xeon® 4th Gen (or better), Intel® Core® i-series 12th Gen (or better), AMD® Ryzen® 5 Gen 3 (or better)
 - .3 Memory: 16 GB DDR4 minimum, 32 GB or more recommended for larger systems
 - .4 Hard Drive: SSD 512 GB minimum, more recommended depending on archiving requirements
 - .5 Network Support: Ethernet adapter (10/100/1000 Mb with RJ-45 connector)
 - .6 Video: 1080p (1920 x 1080) minimum resolution
 - .7 Operating System: Windows 11 x64-bit; Windows Server 2025; Linux x64-bit: RedHat Enterprise Linux 9.x, Ubuntu 24.04 LTS
 - .8 Browser: Chrome, Firefox, Microsoft Edge
 - .9 Mobile Browser: Safari on iOS, Chrome on Android
 - .10 Relational Database (optional): MS SQL Server 2022; MySQL Server 9.0
 - .11 Container Engine (for Containerized Supervisors): Docker, Inc.

- 2.4.3. Provide industry standard hardware that meets or exceeds DDC System manufacturer recommended specifications
- 2.4.4. Hard Disk to be capable of storing system software, one year of archive trend data at 15minute intervals and system database that is not less than twice the size of the database required when system is accepted. Provide additional external storage space if required.
- 2.4.5. Minimum server configuration to be the equivalent of current DELL or IBM small business server class computers.
- 2.4.6. Support Multi-Tasking and multi-user, TCP/IP network, Graphic Display Building Editor, Application software.
- 2.4.7. Operating system shall be Windows 10 LTSC using version 2019 or the latest compatible version.
- 2.4.8. Server shall include dual redundant power supplies. Server shall include data redundant hard disks (RAID).
- 2.4.9. All servers will be a 19-inch rack mountable.
- 2.5. OPERATOR INTERFACE
 - 2.5.1. Operator Software:
 - .1 Ensure new BAS addition is compatible with existing BAS. The integration to be seamless. If existing BAS is available remotely, new addition to also have the exact same experience and capabilities.
 - .2 Storage: Store trend data in Owner's server. Maintain twelve consecutive months of trend data on the Server for benchmark data. Store Analog data at 15 minute intervals and digital data when there is a change of value.
 - 2.5.2. NIAGARA ANALYTICS – GENERAL
 - .7 Provide a fault detection and analytic framework that utilizes a high-performance calculation engine. The engine shall permit real-time data to be combined with historical data using a set of wire and property sheets. The visual programming interface shall be used to define the algorithms (formulas) that analyzes the real-time and trend data collected from the BMS. At a minimum, Analytics for BMS fault detection and diagnostics, including sub-system alarm suppression as described in ASHRAE Guideline 36-2021 shall be provided.
 - .8 The output from the analysis shall be able to be visualized in charts, graphs and dashboards and be used as inputs to standard Niagara logic. Faults shall be prioritized according to the associated system, location, and the level of cost avoidance.
 - .9 When applied to historical and real-time data, the framework algorithms shall provide the following analysis features:
 - .10 An open and extensible analytical environment that can easily customized.
 - .11 Analytic tools that apply to any data types available from building sub-systems.
 - .12 The ability to set-up complex analysis without custom programming.
 - .13 Support for third party API visualization application programs

2.6. 3RD PARTY MANUFACTURER INTERFACE.

- 2.6.1. 3rd party manufacturer controllers included but not limited to chillers, boilers, variable frequency drives, power monitoring, medical gasses to be based on the open system communication (BACnet) for seamless integration with BAS. Include network connection from BAS to 3rd party manufacturer controllers.
- 2.6.2. If 3rd party manufacturer controllers are based on different open system standard than BAS, it is the responsibility of BAS Contractor to provide the appropriate interface for integration of that 3rd party manufacturer controller to BAS.
- 2.6.3. If open system controllers are not available, include all appropriate hardware equipment and software to allow bi-directional data communication between the BAS and 3rd party manufacturers' control panels.

2.7. CONTROLLER RESIDENT SOFTWARE

- 2.7.1. The software resides in Building Controllers and Advanced Application Controllers and is edited by means of the Operator Interface.
- 2.7.2. Security:
 - .1 Definition: Multiple operators are assigned access levels, and independent user login names and passwords are configurable.
 - .2 Processing: Automatically log off operator after an adjustable period of inactivity.
- 2.7.3. Alarms and Events:
 - .1 Definition: Alarm limits, alarm limit differentials, states and reactions shall be adjustable.
 - .2 Processing: Alarm and event messages are independently configured to route to network devices. Enable and disable alarms and events manually by the operator and automatically through Custom Application Programs.
- 2.7.4. Trends:
 - .1 Definition: Create, delete and modify trends. Title blocks, legends, sampling interval and start and stop time shall be configurable.
 - .2 Storage: Trend data is retrieved by the Operator Interface.
 - .3 Create trend logs for all AI/AO/BI/BO of the BAS. Analog points to be at 15 minute intervals and Digital points to be at Change of Value.
- 2.7.5. Time-of-Day (TOD) Schedules:
 - .1 Definition: Create, delete and modify TOD Schedules. Assign objects to TOD Schedules based on function and location.
- 2.7.6. Custom Application Programs (Algorithms):
 - .1 Definition: Create, delete and modify programs and program statements.
 - .2 Syntax Capabilities:
 - .1 Analog and binary point objects.
 - .2 Conditional statements (IF, THEN, ELSE, ELSE IF) using compound Boolean relations (AND, OR and NOT) and comparisons (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL).
 - .3 Floating-point arithmetic using operators for addition, subtraction, division, multiplication and square root; absolute value and minimum/maximum value arithmetic functions.

- .4 Predefined objects representing date, time of day, day of week, month of year and elapsed time.
 - .5 Create, delete and modify custom function blocks.
- 2.7.7. Maintenance Messages: Display at Operator Workstations. Indicate equipment name and maintenance required based on equipment run time, starts, and calendar date limits.
- 2.7.8. PID Control: PID (proportional-integral-derivative), PI and P algorithms for direct acting and reverse acting. Analog output is time-varying. Output control device is adjustable by the operator. Set point and gains are adjustable.
- 2.7.9. Optimal Start/Stop: Delay equipment start-up to latest possible time which will allow building space to reach target conditions by occupancy time. Advance shut-down of equipment to earliest possible time and maintain space target conditions until the end of occupancy time.
- 2.7.10. Enthalpy Economizer Control: Control outside, return and exhaust dampers based on inside and outside enthalpy comparisons.
- 2.7.11. Electrical Demand Management: Manage electrical demand by monitoring power consumption. If consumption exceeds operator adjustable level system to be capable of adjusting set-points, de-energizing low priority equipment and taking other pre-programmed actions as described in SEQUENCES OF OPERATION.
- 2.7.12. Chiller Optimization: sequence chillers and other chilled water plant equipment and reset chilled water and condenser water control set points, to provide cooling at minimum cost.
- 2.7.13. Load Reset: use the zone with the greatest load to reset the set-point of heating or cooling source.
- 2.7.14. Morning Warm-Up: compare outside and space temperatures and if outside air temperature is less than desired space temperature, run the system before occupancy with fully closed outside dampers until space temperature is satisfied.
- 2.7.15. Night Cool Down: compare outside and space temperatures and if outside air temperature is less than desired space temperature, run the system during unoccupied hours with outside dampers fully opened until space temperature is satisfied.
- 2.7.16. Equipment Sequencing: Sequence equipment with lead - leg, duty - standby and priority assignment based upon runtime or operator command as described in SEQUENCES OF OPERATION.
- 2.7.17. Staged Starts: Operator selectable time delays between starts for equipment on power restoration or scheduled start.
- 2.7.18. Anti-Short Cycling: Minimum on and minimum off times for equipment.
- 2.7.19. Dead-band Switch: Cycle a binary point object based on controlled point object and set point for direct acting and reverse acting. Differentials are adjustable.
- 2.7.20. Equipment Run Time Totalization: Accumulated run time expressed in unit hours and operator adjustable high runtime alarms.
- 2.8. DDC CONTROLLERS
 - 2.8.1. General
 - .1 Input/Output Interface
 - .1 Minimum Spare I/O Capacity: Controllers to have minimum 20% spare capacity or at least one of each type of I/O available on the controller. This does not apply to Application Specific Controllers
 - .2 Controllers to be swappable without disconnecting the wiring.

- .3 Controllers to continue to provide control functions in event of network communications failure.

2.9. DDC CONTROLLERS

2.9.1. General

- .1 Input/Output Interface:
 - .1 Analog Inputs:
 - .1 Signal: 4 to 20 mA, 0 to 10 VDC, thermistor, RTD.
 - .2 Binary Inputs:
 - .1 Detect dry contact closure.
 - .2 Wetting Current: Supplied by the controller.
 - .3 Pulsed Inputs:
 - .1 Detect pulse of dry contact closure.
 - .2 Pulse Frequency: Compatible with input device.
 - .3 Wetting Current: Supplied by the controller.
 - .4 Analog Outputs:
 - .1 Signal: 4 to 20 mA, 0 to 10 VDC. Provide range and zero adjustment.
 - .2 Accuracy Rating: +/- 1% of scale length.
 - .5 Binary Outputs:
 - .1 Triac: Rated for 0.5 A at 24 VAC
 - .2 Relay: NO or NC configuration, rated for 3 A at 24 VAC
 - .3 Provide secondary relay for higher loads.
 - .6 Minimum Spare I/O Capacity: Controllers to have minimum 20% spare capacity or at least one of each type of I/O available on the controller. This does not apply to Application Specific Controllers.
- .2 Controllers that perform scheduling operations to have on board real-time clock.
- .3 Controllers to continue to provide control functions in event of network communication failure.
- .4 Controllers to be swappable without disconnecting the wiring.
- .5 Immunity to Power: Rated for 90% to 110% of nominal voltage.

2.9.2. Building Controllers (BC):

- .1 Independent, networked, microprocessor-based for all internetwork control strategies.
- .2 Reside on Ethernet Tier 1 BAS network.
- .3 Manage connected input and output control devices; transmit real and virtual point object data to distributed controllers and Operator Interfaces and provide global strategy and direction.
- .4 Continuous monitoring of processor, memory and communication circuits; assume a predetermined failure mode for abnormal conditions; assume a failsafe operating mode for failed communication with objects.
- .5 Communicates to card access, security, fire alarm, lighting control systems.
- .6 Service communication port for communication with Portable Operator Terminals.

- .7 Memory: Non-volatile EEPROM for firmware. Seventy-two hours battery backed memory for object database and custom application programs.
 - .8 Each BC to support firmware upgrades without need to replace hardware.
 - .9 Environment: Suitable for anticipated ambient conditions.
 - .10 Serviceability: LEDs for power, communication and processor status.
- 2.9.3. Advanced Application Controllers (AAC):
- .1 Independent, networked, microprocessor-based.
 - .2 Reside on lower tier BAS network (BACnet or LON).
 - .3 Manage connected input and output control devices; transmit real and virtual point object data to distributed controllers and Operator Interfaces.
 - .4 Continuous monitoring of processor, memory and communication circuits; assume a predetermined failure mode for abnormal conditions; assume a failsafe operating mode for failed communication with objects.
 - .5 Service communication port for communication with Portable Operator Terminals.
 - .6 Memory: Non-volatile EEPROM for firmware. Seventy-two hours of battery backed memory for object database and custom application programs.
 - .7 Each AAC to support firmware upgrades without need to replace hardware.
 - .8 Environment: Suitable for anticipated ambient conditions.
 - .9 Serviceability: LEDs for power, communication and processor status.
- 2.9.4. Application Specific Controllers (ASC):
- .1 Microprocessor-based networked. Non-adjustable programs with operator adjustable settings for customized operation within equipment design limits.
 - .2 Reside on lower tier BAS network (BACnet or LON).
 - .3 Service communication port for communication with Portable Operator Terminals.
 - .4 Memory: Non-volatile EEPROM memory for firmware and program data.
 - .5 Environment: Suitable for anticipated ambient conditions.
 - .6 Serviceability: LEDs for power, communication and processor status.
- 2.10. POWER SUPPLIES AND LINE FILTERING
- 2.10.1. Provide a separate power supply for every Building Controller, Advanced Application Controller and Application Specific Controller for terminal units.
- 2.10.2. Power Supplies:
- 2.10.3. Power Supply Voltage: 24 V, unless indicated otherwise on Drawings.
- 2.10.4. Type: Enclosed; Class 2 current-limiting, or over-current protection in primary and secondary circuits for Class 2 service to the National Electrical Code.
- 2.10.5. Applied Loads: To 80% of rated capacity.
- 2.10.6. DC Power Supplies: Regulated output.
- 2.10.7. Built in over voltage and over current protection.
- 2.10.8. Able to withstand 150% current overload for at least 3 seconds without trip or failure.
- 2.10.9. Power Line Filtering: Provide internal or external transient voltage and surge suppression for workstations and controllers.

2.11. CABINETS

- 2.11.1. Type: NEMA rated and suitable for installed environment.
- 2.11.2. Door: Hinged with key-lock latch with common key for all cabinets; provide duplicate keys; for Application Specific Controllers provide screwed tight slide-off cover.
- 2.11.3. Controllers, transducers and relays mounted on backing board or DIN rails within inner section behind hinged doors.

2.12. CONTROL DEVICES

- 2.12.1. For smoke dampers, and combination smoke and fire dampers, refer to the requirements of Section 23 31 13.00 – DUCTWORK AND SPECIALTIES.
- 2.12.2. Motorized Control Dampers:
 - .1 Sizing:
 - .1 Dimensions: As indicated. Maximum damper section size: 1200 mm x 1500 mm (48 in. x 60 in.). For dampers larger than the section maximum, use an assembly of multiple, equally sized sections.
 - .2 Two-position: Parallel blade.
 - .3 Modulating: Opposed blade. Parallel blade dampers may be used for return air and bypass applications.
 - .2 Frame: 125 mm x 25 mm x 3 mm (5 in. x 1 in. x 0.125 in.) 6063T5 extruded aluminum with mounting flanges on both sides.
 - .3 Blades: Airfoil shape, 6063T5 extruded aluminum, maximum 150 mm (6 in.) depth.
 - .4 Seals:
 - .1 Blade Edge: Extruded thermoplastic rubber (TPR) suitable for -58 deg. C to 135 deg. C (-72 deg. F to 275 deg. F), mechanically locked in place and easily replaceable in the field.
 - .2 Blade Jamb: Spring-loaded stainless steel.
 - .5 Bearings: Molded synthetic.
 - .6 Linkage: Corrosion resistant steel and concealed in the frame.
 - .7 Drive Shaft: Corrosion resistant steel of square or hexagon shape.
 - .8 Axle: Corrosion resistant steel.
 - .9 Leakage: Maximum 40.6 L/s/sq m (8 CFM/sq ft) at 1.0 kPa (4 in. w.g.) of differential pressure across fully closed damper when tested to AMCA Standard 511.
 - .10 Make and Model: Ruskin CD-50 or equivalent.
- 2.12.3. Motorized Control Dampers (Thermally Insulated):
 - .1 Sizing:
 - .1 Dimensions: As indicated. Maximum damper section size: 1524mm x 1829 mm (60 in. x 72 in.). For dampers larger than the section maximum, use an assembly of multiple, equally sized sections.
 - .2 Two-position: Parallel blade.
 - .3 Modulating: Opposed blade. Parallel blade dampers may be used for return air and bypass applications.
 - .2 Frame: 125 mm x 25 mm x 3 mm (5 in. x 1 in. x 0.125 in.) 6063T6 extruded aluminum with mounting flanges on both sides.

- .3 Blades: Airfoil shape, 6063T6 extruded aluminum, maximum 150 mm (6 in.) depth, injected with high density polyurethane foam insulation with thermal isolation gap.
 - .4 Seals:
 - .1 Blade Edge: Mechanically fastened extruded Ruskiprene suitable for -43 deg. C to 85 deg. C (-45 deg. F to 185 deg. F), and easily replaceable in the field.
 - .2 Blade Jamb: Ribbed extruded Ruskiprene.
 - .5 Thermal Efficiency Ratio: 345 % or higher.
 - .6 Linkage: Corrosion resistant steel and concealed in the frame.
 - .7 Drive Shaft: Corrosion resistant steel of square or hexagon shape.
 - .8 Axle: Corrosion resistant steel.
 - .9 Leakage: Maximum 40.6 L/s/sq m (8 CFM/sq ft) at 1.0 kPa (4 in. w.g.) of differential pressure across fully closed damper when tested to AMCA Standard 511.
 - .10 Make and Model: Ruskin TED-50 or equivalent.
- 2.12.4. Actuators For Dampers, Electronic:
- .1 Actuator Type: Modulating, except as indicated below for VAVs.
 - .2 Control Signal: Compatible with BC, AAC and ASC.
 - .3 Floating control signal is acceptable only for VAV damper application.
 - .4 Operating Time: Maximum 120 seconds throughout the full rotation.
 - .5 Angle of Rotation: Adjustable between 0° to 90°.
 - .6 Stall protection: Mechanical or electronic.
 - .7 Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation.
 - .8 Failsafe:
 - .1 For VAV terminals, refer to Section 23 36 16.00 – VARIABLE VOLUME BOXES.
 - .2 For generator applications, refer to Section 23 35 16.00 – ELECTRIC POWER GENERATOR.
 - .3 For other applications, drive damper to fail position in 15 seconds.
 - .9 Manual Override: Crank type. External gear release for fail in place actuators.
 - .10 Position Indicator: Reversible for clockwise or counter-clockwise rotation; set the 0 degrees mark to the failsafe position.
 - .11 Torque: To damper manufacturer's requirements to provide complete compression of seals between frame and blades and for smooth control.
 - .12 Provide 2 adjustable SPDT auxiliary switches to prove open-closed.
- 2.12.5. Control Valves:
- .1 Characteristics, materials and pressure ratings suitable for the application; refer to schedules.
 - .2 Flow Characteristic:
 - .1 Water:
 - .1 Two-way: Equal percentage.
 - .2 Three-way: A Port: Equal percentage. B Port: Linear or modified linear.
 - .3 Sizing Water Valves:
 - .1 Two-position: Line size with full ports.

- .2 Two-way Modulating: Non Radiation: Pressure drop equal to the pressure drop through the coil or 27 kPa (4 psi), whichever is greater. Radiation: Pressure drop equal to 7 kPa (1 psi).
- .3 Three-way Modulating: Non Radiation: Pressure drop equal to the pressure drop through the coil or 27 kPa (4 psi), whichever is greater. Radiation: Pressure drop equal to 7 kPa (1 psi).
- .4 Butterfly Valves:
 - .1 Type: High-performance (HPBV).
 - .2 Make and Model: Dezurik BHP or equivalent.
 - .3 Tee-fitting: Provide for three-way application; with motor mounting bracket and linkage hardware.
- .5 Valves 12 mm (1/2 in.) through 50 mm (2 in.):
 - .1 Screwed ANSI Class 250 bronze body.
- .6 Valves 62 mm (2-1/2 in.) and Larger:
 - .1 Water temperature less than 121 deg. C (250 deg. F) at 1035 kPa (150 psi) or less than 93.2 deg. C (200 deg. F) at 1139 kPa (165 psi): Flanged ANSI Class 125 cast iron body.
 - .2 Water temperature greater than 121 deg. C (250 deg. F) at 1035 kPa (150 psi) or greater than 93.9 deg. C (200 deg. F) at 1138 kPa (165 psi): Flanged ANSI Class 250 cast iron body or ANSI Class 300 cast steel body.
- .4 Sizing Steam Valves:
 - .1 Two-position: Pressure drop equal to 10% to 20% of inlet pressure.
 - .2 Modulating: Pressure drop equal to 50% of inlet pressure.
 - .3 Leakage: ANSI Class IV.
 - .4 Materials:
 - .1 Stems: Stainless steel.
 - .2 Plugs and Seats: Brass or steel.
 - .3 Packing: PTFE for steam.
 - .5 Rangeability: 40:1 minimum.
- 2.12.6. Pressure Independent Control Valves:
 - .1 Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of the piping system, unless otherwise indicated.
 - .2 Calibrated Balancing Valves and Automatic Flow-Control Valves shall not be required on devices where pressure independent control valves are installed.
 - .3 The control valves shall accurately control the flow from 0 to 100% full rated flow with an equal percentage flow characteristic.
 - .4 Each control valve shall be individually flow tested and factory verified to deviate no more than $\pm 5\%$ through the operating pressure range. A calibrated performance tag shall be provided with each valve (optional for 1/2" [15mm]) listing the measured flow rate in 10° rotation increments.
 - .5 Valve bodies 2" [50mm] and smaller shall be brass. Valve bodies 3" [80mm] thru 8" [200mm] shall be ductile iron. All internal parts shall be brass, carbon steel, stainless steel or Teflon®. Plastic internal parts are not acceptable

- .6 Control valve rangeability shall be 100:1 minimum.
 - .7 Warrant all components for a period of 5 years from the date of Substantial Performance of the Work.
 - .8 The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory, or shall be provided with universal mounting plate to allow installation of actuators meeting system electrical and valve torque requirements.
 - .9 If valves have additional features such as energy management or temperature monitoring, these aspects are to be fully integrated into BAS using BACnet IP or MS/TP. All available information to be communicated to BAS.
 - .10 All necessary low-voltage power requirements for the valves should be provided.
- 2.12.7. 6-way control valves and actuators
- .1 Construction: Size 13 mm to 19 mm (1/2 in to 3/4 in)
 - .1 Body: forged brass
 - .2 Ball: chrome plated forged brass
 - .3 Stem: chrome or nickel plated forged brass or stainless steel
 - .4 Seat: PTFE
 - .5 O-rings: EDPM
 - .6 Pressure rating: minimum 1586 kPa (230 psi) with minimum close off pressure of 345 kPa (50 psi)
 - .7 Temperature rating: 6 deg. C (43 deg. F) to 82 deg. C (180 Deg. F)
 - .2 Option 1:
 - .1 Actuator: 6 way control valve, 90 degrees range, manual over-ride, 24 VAC, fail in place operation. First 30 degrees opens source A, next 30 degrees valve is closed, final 30 degrees opens source B.
 - .1 Flow characteristics: Linear
 - .2 Pair with a pressure independent balancing control valve to achieve equal percentage characteristics for both flow streams.
 - .2 Manufacturers:
 - .1 Victaulic TA Series 76W 6 way valve with TA M106 CO Actuator; and
 - .2 Victaulic TA-Modulator pressure independent balancing control valve
 - .3 Option 2:
 - .1 Actuator: 6 way control valve, 90 degrees range, manual over-ride, 24 VAC, fail in place operation. First 30 degrees opens source A, next 30 degrees valve is closed, final 30 degrees opens source B.
 - .1 Flow characteristics: Linear using characterized ball valve.
 - .2 Select valve flow coefficient (Cv) for each source separately and specifically for this application.
 - .2 Manufacturers:
 - .1 Siemens: 599 Series 6-way ball valve.
 - .2 Belimo: 6-Way Characterized Control Valves (CCV)
- 2.12.8. Actuators for Control Valves, Electronic:
- .1 Type: Modulating, proportional flow control.
 - .2 Control Signal: Compatible with BC, AAC and ASC.

- .3 Floating control signal is not acceptable.
 - .4 Operating Time: Maximum 120 seconds throughout the full rotation.
 - .5 Mounting: Corrosion resistant hardware.
 - .6 Stall Protection: Electronic overload or digital rotation sensing.
 - .7 Failsafe: Fail in place for terminal reheat coils; fail open for all other heating valves; fail open for critical cooling valves (e.g. server or IT rooms), fail closed for all other cooling valves. Spring return to fail position within 15 seconds. Battery or capacitor return are not acceptable. Refer to Sequence Of Operation for alternate fail positions as may be required.
 - .8 Manual Override: Crank type. External gear release for fail in place actuators.
 - .9 Position Indicator: Provide. Indicate valve open and closed positions.
 - .10 Sound level: Provide actuator with 30 dBA maximum sound level where valves are located within or near bedrooms. Provide additional acoustic cover as may be required to meet acoustic requirements in these areas. Confirm acoustic cover will not result in overheating of actuator. Coordinate cover to fit within radiator cabinets as may be required.
 - .11 Close-off Pressure:
 - .1 Water:
 - .1 Two-way: 150% of total system head.
 - .2 Three-way: 300% of the pressure differential between ports A and B at design flow, or 100% of total system head.
 - .2 Steam: 150% of inlet pressure.
- 2.12.9. Electric Relays:
- .1 Type: General purpose; enclosed coil; diodes provided for inductive switched loads; override button; LED "energized" indicator; plug-in type base.
 - .2 Contact rating, configuration and coil voltage suitable for application.
 - .3 Regulatory: UL listed.
- 2.12.10. Damper End Switches:
- .1 Type: Lever operated activated by blade position.
 - .2 Electrical Contacts: Rated for 10 A resistive, 6 FLA at 120 VAC.
 - .3 Regulatory: UL listed.
- 2.12.11. Level Switches:
- .1 Type: Float.
 - .2 Electrical Contacts: Rated for 10 A resistive, 6 FLA at 120 VAC.
 - .3 Mounting: Outside of measured fluid.
 - .4 Enclosure: NEMA rated for the application.
- 2.12.12. Ultrasonic Level Transmitter:
- .1 Service: Compatible fluids. Not for use with powder and bulk solids.
 - .2 Accuracy: $\pm 0.2\%$ of maximum range.
 - .3 Resolution: 0.079" (2 mm).
 - .4 Output Signal: 4 to 20 mA (Two-wire).
 - .5 Temperature Compensation: Automatic.

- .6 Enclosure Rating: NEMA rated for the application.
- .7 Failsafe: On lost echo after 30 seconds, user selectable to 4, 20, 21, 22 mA or last signal.
- .8 Display: 6 character LCD.
- .9 Agency Approvals: CE compliance, FM approved.
- 2.12.13. Low Limit Electromechanical Thermostat:
 - .1 Type: Vapour Pressure; minimum 6000 mm (20 ft.) of capillary; actuated by any 300 mm (12 in.) of capillary element; manual reset upon activation.
 - .2 Electrical Contacts: Double-pole double-throw (DPDT), snap-acting; rated for 10 A resistive, 6 FLA at 120 VAC.
 - .3 Adjustable Set Point: Range: -1 deg. C to 13 deg. C (30 deg. F to 55 deg. F) and set to 1.67 deg. C (35 deg. F).
 - .4 Regulatory: UL listed.
- 2.12.14. High Limit Electromechanical Thermostat:
 - .1 Type: Bimetallic sensing; manual reset upon activation.
 - .2 Mounting: Air stream.
 - .3 Electrical Contacts: Single-pole single-throw (SPST), normally closed, snap-acting; rated for 10 A resistive, 6 FLA at 120 VAC.
 - .4 Adjustable Set Point: Range: 38 deg. C to 66 deg. C (100 deg. F to 150 deg. F) and set to 57 deg. C (135 deg. F).
- 2.12.15. Electromechanical Thermostat:
 - .1 Wall Mount:
 - .1 Provide samples of covers to Part 1: Submittals, Samples.
 - .2 Low Voltage:
 - .1 Type: 24 VAC, bimetal-operated, mercury-switch; adjustable or fixed anticipation heater; vented ABS plastic concealed cover.
 - .2 Set Point: Range: 13 deg. C to 30 deg. C (55 deg. F to 85 deg. F); 1 deg. C (2 deg. F) maximum differential.
 - .2 Line Voltage:
 - .1 Type: Bimetal-actuated open contact, or bellow-actuated enclosed snap-switch type, or equivalent solid state type; anticipation heater; vented metal concealed cover.
 - .2 Electrical Contacts: Rated for 10 A resistive, 6 A FLA at 120 VAC.
 - .3 Set Point: Range: 13 deg. C to 30 deg. C (55 deg. F to 85 deg. F); 1 deg. C (2 deg. F) maximum differential.
 - .4 Regulatory: UL listed.
- 2.12.16. Digital Thermostat:
 - .1 Digital thermostats shall be 7-day programmable digital type suited for the application.
 - .2 Standalone terminal units shall utilize a digital thermostat where shown on Drawings.
 - .3 Digital thermostat shall have user selectable engineering units (F or C) and set point adjustment.
 - .4 Digital thermostat shall support automatic daylight savings time switchover.

- .5 Digital thermostat shall support automatic and manual heat/cool changeover when applicable.
 - .6 Digital thermostat shall support temporary set point adjustment with automatic return to normal operation.
- 2.12.17. Temperature Sensors:
- .1 General Requirements:
 - .1 Temperature sensors shall be of the resistance type, two-wire 1000 ohm nickel RTD, two-wire 1000 ohm platinum RTD or two-wire 10,000 ohm thermistor.
 - .2 Space Temperature Sensors:
 - .1 Stainless Steel plate sensors or white-plate sensors For installation throughout the facility where local control is not required (such as corridors or lobby) unless otherwise noted.
 - .3 Space Temperature Sensors With Adjustable Set-Point, Override and Display:
 - .1 Key pad or slider for temperature set-point adjustment.
 - .2 LED display.
 - .3 Timed override request push button with LED status for activation of after-hours operation.
 - .4 For installation only where indicated on Drawings, controls diagrams or sequences of operations.
 - .4 Covers for Wall Mount Sensors:
 - .1 Overrides: Exposed set point adjustment and override button.
 - .2 Communication Port: For communication between Portable Operator Terminals and ASC controllers.
 - .5 Averaging Temperature Sensors:
 - .1 Minimum 1.5 m (5 ft) of capillary per 1 sq m (10 sq ft) of duct cross-section.
 - .2 Provide multiple sensors where single averaging element is unable to be positioned to provide complete duct or plenum traverse.
 - .6 Outside Air Temperature Sensors:
 - .1 Outside air temperature sensors shall be designed to withstand the environmental conditions to which they will be exposed.
 - .2 The sensors shall be provided with a solar shield.
 - .3 Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
 - .7 Duct Temperature Sensors:
 - .1 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - .2 Probe length shall be no less than 1/3 of the duct width or diameter.
 - .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
 - .8 Thermowells:
 - .1 Brass or Type 316 stainless steel suitable for the application.
 - .2 Heat transfer compound compatible with sensing element.
 - .9 Guards for Sensors and Thermostats:

- .1 Materials: Heavy gauge steel.
- 2.12.18. Relative Humidity Sensors:
 - .1 Sensors shall be calibrated to NIST standards.
 - .2 Sensing Element:
 - .1 Type: Thin film capacitance.
 - .3 Transmitter:
 - .1 Range: 0 to 100% RH.
 - .2 Signal: 4 to 20 mA or 0-10 VDC with span and zero adjustment.
 - .4 Accuracy Rating: +/- 2 % of output reading.
 - .5 Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure.
 - .6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
- 2.12.19. Pressure Sensors:
 - .1 General:
 - .1 Sensing Element:
 - .1 Type: Capacitance sensing.
 - .2 Materials: Suitable for continuous contact with measured medium.
 - .2 Transmitter:
 - .1 Range: Not to exceed two times the operating pressure.
 - .2 Signal: 4 to 20 mA or 0-10 VDC; with zero and span adjustment.
 - .3 Accuracy Rating: +/- 1.0 % of full scale.
 - .4 Response Time: Maximum 0.5 seconds.
 - .3 Isolation Valve: Between process connection and sensor.
 - .1 Capable of withstanding 100% overpressure without damage
 - .4 Air Static Pressure Sensors:
 - .1 Sensing Element:
 - .1 Type: Capacitance sensing with pitot tube sensing tips screwed securely to duct.
- 2.12.20. Submersible Pressure Sensor:
 - .1 The sensor housing shall be made from high strength stainless steel or titanium for pressure ranges 1.25 times the maximum system pressure and compatible with a wide range of liquids.
 - .2 The sensor shall be vented through the cable to correct for barometric pressure changes.
 - .3 Sensor over range protection shall be two times rated pressure.
 - .4 Accuracy shall be +/- 0.25% of the full scale or better.
 - .5 Available control signals shall be 2-10 VDC or 4-20 mA.
- 2.12.21. AC Current Sensing Switches:
 - .1 Type: Self-powered solid-state with split-core.
 - .2 Electrical Contacts: Rated for 1 A resistive at 30 VAC/DC.

- .3 Insulation Rating: 600 VAC.
- .4 Adjustable trip point with LED status indicator.
- 2.12.22. AC Current Transducers:
 - .1 Type: Self-powered or loop-powered solid-state with split-core.
 - .2 Amperage Range: Motors: Factory calibrated to LRA; Switchgears: Factory calibrated to design load.
 - .3 Insulation Rating: 600 VAC.
 - .4 Signal: 4 to 20 mA or 0-10 VDC; internal zero and span adjustment.
 - .5 Accuracy Rating: +/- 2 % of full scale.
 - .6 Regulatory: UL listed or CSA approved.
- 2.12.23. CO2 Sensors:
 - .1 Sensor shall employ non-dispersive infrared technology (NDIR).
 - .2 Accuracy shall be +/- 75 ppm over 0-1500 ppm range.
 - .3 Response time shall be less than 1 minute.
 - .4 Sensor shall have field selectable 0-10 VDC and 4-20 mA outputs.
 - .5 Power voltage shall be 20-30 VDC/AC.
 - .6 Operating temperature range shall be 0°C to 50°C.
 - .7 The sensor shall be wall mount.
- 2.12.24. Gas Detection System:
 - .1 Gas Detection Controller:
 - .1 Use: Centralized gas detection monitoring with real-time gas reading, selective alarm activation
 - .2 Enclosure: NEMA 4X Polycarbonate - ABS
 - .3 Power Requirement: 17-27 Vac, 24-38 Vdc, 500 mA
 - .4 Network: Three Modbus channels for up to 96 transmitters and an optional BACnet/LON/IP output; Communication Line Up to 609 m (2000 ft.) per channel
 - .5 Alarm Levels: fully programmable alarm levels; Time Delays 0, 30 sec., 45 sec., 1-99 minutes before and after alarm
 - .6 Outputs: 4 DPDT relays (alarms and/or fault) at 5 A, 30 Vdc or 250 Vac (resistive load); 65dBA buzzer
 - .7 Display: 122 x 32 dot matrix LCD display
 - .8 Operating Humidity Range: 0-95% RH, non-condensing
 - .9 Operating Temperature Range: -20 to 50°C (-4 to 122°F)
 - .10 Certifications: CAN/CSA C22.2 No 61010-1
 - .11 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)
 - .12 Make and Model: Honeywell 301C, Belimo Opera Model 6000, or equivalent.
 - .2 Wired or Stand-Alone Gas Transmitter:
 - .1 Use: Wall mounted, wired gas detector transmitter used in conjunction with controller

- .2 Power Requirement: 24 Vac nominal (17-27), 50/60 Hz, 0.35A; 24 Vdc nominal (20-38Vdc)
- .3 Network: Modbus RS-485; BACnet MS/TP master
- .4 Display: 8 character, 2 line backlit LCD
- .5 Visual Indicators: Green LED; Power, Amber LED 1: Alarm/ Fault, Amber LED 2: Alarm/ Fault
- .6 Audible Alarm: >85 dBA at 3m (10ft)
- .7 Relay Output: Network 1 DPDT relay, 5A @ 250Vac; 5A @ 30 Vdc; Stand Alone 2x DPDT relay, 5A @ 250Vac; 5A @ 30 Vdc
- .8 Sensing Technology: Toxic = Electrochemical; Combustibles = Catalytic; Oxygen = Diffusion fuel cell
- .9 Accuracy: Toxic, Combustibles, Oxygen = +/- 3%
- .10 Detection Range: Carbon Monoxide = 0 - 250 ppm; Nitrogen Dioxide (NO₂) = 0-10 ppm; Oxygen = 0-1 ppm; Combustibles = 0-100% LEL;
- .11 Certified to: CAN/CSA C22.2 No. 61010-1
- .12 Conforms to: ANSI/UL 61010-1
- .13 Sensors Make and Model: Honeywell E3 Point, Belimo Opera Model 6000, or equivalent.

2.12.25. Refrigerant Gas Detection System:

- .1 Gas Detection Controller /Expansion Module - Inside Mechanical Room
 - .1 Use: Centralized Stand Alone refrigerant gas detection monitoring main controller with real-time gas reading, selective alarm activation
 - .2 Power Requirement: 22-27 Vac, 29-38 Vdc, 2A max @ 29Vdc
 - .3 Up to 20 gas transmitters, Digital Communication Modbus RS-485 Line, Up to 61 m (200 ft.) from the controller.
 - .4 Alarm Levels: 3 fully programmable alarm levels
 - .5 Outputs: 4 DPDT form C relays (alarms and/or fault) at 5 A, 30 Vdc or 250 Vac (resistive load); 65dBA buzzer, 3 Outputs at 24 Vdc @ 250 mA each
 - .6 Integral Strobe/Horn: STAS flashing LED/105dBA, 4-28V, 2800Hz (RFSA)
 - .7 Display: 122 x 32 dot matrix backlit LCD display
 - .8 Visual Indicators: - Green LED - Normal Operation
 - .9 Red LED Gas Alarm A, B, and C
 - .10 Yellow LED: Fault/Service
 - .11 The Controller/expansion module must provide all the functionalities necessary to comply with current ASHRAE 15 guidelines and CSA B-52 Mechanical Codes.
 - .12 Manual Fan Start/Stop operation
 - .13 Audible Alarm with a silence key to acknowledge
 - .14 Visible Alarm
 - .15 Operating Humidity Range: 0-95% RH, non-condensing
 - .16 Operating Temperature Range: 0°C to 40°C (32°F to 100°F)
 - .17 Enclosure rating: NEMA 4X, ABS - Polycarbonate - indoor
 - .18 Certifications: CAN/CSA C22.2 No 61010-1

- .19 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)
- .20 Make and Model: Honeywell 301EM RFSA or equivalent
- .2 Gas Detection Remote Annunciator Panel: Outside Mechanical Room
 - .1 Use: Remote Annunciator / Slave display panel located outside each entrance to Mechanical room
 - .2 Power Requirement: 22-27 Vac, 50 or 60 Hz, 29-38 Vdc, 2.0 A max @ 24 Vdc
 - .3 Up to 10 remote Annunciator panels can be connected to the main refrigerant gas detection Controller; Digital Communication Modbus RS-485 up to 304m (1000 ft)
 - .4 The remote annunciator panel must provide all the functionalities necessary to comply with Current ASHRAE 15 and CSA B-52 Mechanical Codes. This includes a key for manual "fan start" only operation, strobe/horn audible visual alarm on top of the unit
 - .5 Display 122 x 32 dot matrix backlit LCD display
 - .6 Visual Indicators: - Green LED - Normal Operation
 - .7 Red LED Gas Alarm A, B, and C
 - .8 Yellow LED: Fault/Service
 - .9 The Remote annunciator panel will indicate the exact concentration of refrigerant gas as displayed on the 301EMRFSA Main Controller and the refrigerant gas detected. The LCD display screen will indicate multiple alarm levels for each sensing point
 - .10 Operating Temperature Range: 0°C to 40°C (32°F to 100°F)
 - .11 Enclosure rating: NEMA 4X, ABS - Polycarbonate - indoor
 - .12 Certifications: CAN/CSA C22.2 No 61010-1
 - .13 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)
 - .14 Make and Model: Honeywell 301EM RP RFSA or equivalent
- .3 Wired Refrigerant Gas Transmitter:
 - .1 Use: Wall mounted, wired refrigerant gas detector transmitter used in conjunction with 301EMRFSA controller, Diffusion Type with no internal sample pump or filter maintenance required
 - .2 Power Requirement: 8.5 - 12.5 Vdc, 1A@10 Vdc Maximum
 - .3 Network: Modbus RS-485
 - .4 Sensing Technology: NDIR (Non Dispersive Infrared)
 - .5 Accuracy: ±10ppm @ 50 ppm / ±40 ppm @ 500 ppm
 - .6 Detection Range: Refrigerants 0-1000 ppm
 - .7 Resolution: 1 ppm
 - .8 Response Time (T90) 15 seconds
 - .9 Operating Temperature Range: 0°C to 40°C (32°F to 100°F)
 - .10 0 to 95% RH (non-condensing)
 - .11 Enclosure NEMA 4X ABS/Polycarbonate - Indoor
 - .12 Certified to: CAN/CSA C22.2 No. 61010-1

- .13 Conforms to: ANSI/UL 61010-1
- .14 Make and Model: Honeywell 301IRFS sensors or equivalent.
- 2.12.26. Natural gas generator room gas detection system:
 - .1 Provide natural gas detection system for natural gas generator room as required by CSA B149.1 "Natural gas and propane installation code."
- 2.12.27. Electromagnetic Water Flow Meters:
 - .1 Provide an Electromagnetic Flow Meter complete with integral or remote transmitter.
 - .2 Include with transmitter a backlit graphic display and keypad, housed in a CSA Type 4X enclosure, displaying instantaneous flow rate and totalized flow rate. Provide 24 VDC input voltage. Provide 4-20 mA output signals and programmable pulse.
 - .3 Select the flow meter size based on the minimum and maximum flow range for the application.
 - .4 Provide connections to the piping with ANSI class 150 flanges (ANSI class 300 where required).
 - .5 All wetted materials: 316 stainless steel; liner: ebonite for low temperature service, PTFE for hot water service.
 - .6 Each flow meter: individually wet-calibrated and accurate to within $\pm 0.2\%$ of reading from 0.5 m/s (1.64 fps) to 10 m/s (33 fps) velocity and ± 0.001 m/s (0.004 fps) at flow rates below 0.5 m/s (1.64 fps). Provide a certificate of calibration with each flow meter.
 - .7 Provide flow meter that is capable of measuring bi-directional flow.
 - .8 For installations in non-metallic pipe, provide an internal grounding electrode which eliminates the need for external grounding rings.
 - .9 Factory program each flow meter for its specific application, and make re-programmable using the integral keypad on the converter (no special interface device or computer required).
 - .10 Make and Model: Badger ModMAG M2000, ONICON F-3000 Series Electromagnetic Flow Meter or equivalent.
- 2.12.28. Ultrasonic Water Flow Meters:
 - .1 Provide an Ultrasonic Flow Meter complete with integral or remote transmitter and transducers.
 - .2 Include with transmitter a backlit graphic display and keypad, housed in a CSA Type 4X enclosure, displaying instantaneous flow rate and totalized flow rate. Provide 24 VDC input voltage. Provide 4-20 mA output signals and programmable pulse.
 - .3 Select the flow meter size based on the minimum and maximum flow range for the application.
 - .4 Provide self-aligning mounting hardware including pipe clamps and mounting bracket for the line size and material specified.
 - .5 Provide transducers that are non-wetted utilizing transit time velocity measurement.
 - .6 Provide each flow meter individually NIST calibrated and accurate to within $\pm 1.0\%$ of reading from 0.46 m/s (1.5 fps) to 12.2 m/s (40 fps) velocity. Provide a certificate of calibration with each flow meter.
 - .7 Provide flow meter that is capable of measuring bi-directional flow.
 - .8 Factory program each flow meter for its specific application, and make re-programmable using the integral keypad on the converter (no special interface device or computer required).

- .9 Make and Model: Badger Dynasonics TFX-5000, ONICON F-4300 Series Electromagnetic Flow Meter or equivalent.

2.12.29. BTU Meters:

- .1 Have a single manufacturer build and calibrate the entire BTU metering system and ensure that system consists of a flow meter, two temperature sensors, a BTU meter, temperature thermo wells, and all required mechanical installation hardware. Provide a certificate of NIST (U.S. National Institute of Standards and Technology) traceable calibration with each system. Provide manufacturer's two-year warranty to cover all equipment.
- .2 Provide BTU meter that provides the following information via both an integral LCD, and via network communications (protocol conforming to BACnet or LON): Energy Total, Energy Rate, Flow Total, Flow Rate, Supply Temperature and Return Temperature. Factory program each BTU meter for its specific application, and make re-programmable using the front panel keypad (no special interface device or computer required).
- .3 Provide either an electromagnetic flow meter or an ultrasonic flow meter as specified above.
- .4 Temperature sensors: loop-powered current based (mA) sensors and bath-calibrated and matched (NIST traceable) for the specific temperature range for each application. The calculated differential temperature used in the energy calculation: accurate to within 0.08 deg. C. (0.15 deg. F.) including the error from individual temperature sensors, sensor matching, input offsets, and calculations.
- .5 Make and Model: Badger FC5000/TFX-5000, ONICON System-10 BTU Meter or equivalent.

2.12.30. Gas Sub Meters:

- .1 Provide rotary or diaphragm gas meters complete with integral or remote transmitter.
- .2 Provide programmable pulse transmitter output signal.
- .3 Provide temperature compensated meters for better accuracy.
- .4 Provide meters that comply with ANSI B109 family of standards.
- .5 Provide meters that are Measurement Canada accredited.
- .6 Provide meters to suit pressures and flow rates indicated.
- .7 Make: Elster, Roots Dresser, or equivalent.

2.12.31. Energy Meters:

- .1 The energy meter shall conform to ANSI C12.1 metering accuracy standards.
- .2 The energy meter shall consist of a meter and CTs calibrated together as a system.
- .3 Accuracy shall be +/- 1% from 2-100 % of rated current.
- .4 The energy meter shall not require annual recalibration.
- .5 The energy meter shall derive operating power from its metering connection and shall not require separate control power connection.
- .6 The energy meter electronics shall automatically correct for CT phase reversal.
- .7 LCD display shall show accumulated kWh, Amps, Voltage.
- .8 The energy meter shall have a pulse output with selectable pulse output rates.
- .9 The energy meter shall meet UL and cUL specifications.

2.12.32. Air Flow Stations (Fan Bell Mouth):

- .1 The measuring device shall consist of air flow traverse probes mounted on the fan bell mouth. The probes shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the probe, not be adversely affected by particle contamination normally present in building system airflows. The fan inlet air flow traverse probes (two per inlet) shall have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings and shall be of aluminum construction with hard anodized finish. The fan inlet airflow traverse probes shall not induce a measurable pressure drop, nor shall the sound level with the system be amplified by its presence in the fan inlet bell. The probes shall be capable of producing steady, non-pulsating signals of total and static pressure, without need for flow corrections or factors, with an accuracy of +/- 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.
- .2 Velocity pressure transmitter shall be selected to suit the system working pressures and shall meet the following performance requirements:
 - .1 Calibrated accuracy within +/- 0.25% of span.
 - .2 Repeatability within 0.05% of output.
 - .3 Dead bank & hysteresis not detectable or measurable.
- .3 Square root extractor and multiplier shall meet the following performance requirements:
 - .1 Calibrated Accuracy: +/- 0.5% of flow.
 - .2 Hysteresis: Not detectable.
 - .3 Repeatability: 0.05% of output.
 - .4 Response: 0.5 seconds.
 - .5 Multiplier: Adjustable 0.3 to 2.8.
- .4 Provide a control panel that shall contain all control equipment. Each panel shall have a hinged door, latch and lock.
- .5 Transmitter shall provide a 4 to 20 mA or 0 to 10 VDC signal proportional to flow to the BAS. The signal shall be converted to L/S (CFM) by the BAS.
- .6 The fan inlet airflow traverse probes and velocity pressure transmitter shall be Air Monitor Corporation VOLU-probe/FI and Veltron II.
- .7 Acceptable equal shall be Ebtron Gold Series:
 - .1 The air sensors shall be self heated thermistors and epoxy encapsulated temperature sensors. The heated element shall determine velocity and the other shall provide a reference temperature signal to the velocity sensor to compensate for temperature changes in the air flow. There shall be a minimum of two sensors per type, per inlet.
 - .2 Individual flow sensors shall transmit digital flow/temperature information to a microprocessor based control panel which shall total/average signals and output flow signals (L/S or CFM) to the host DDC panel. The signals shall be linear 0 to 10 VDC or 4 to 20 mA.
 - .3 The velocity linearity shall be 2% of reading, with a repeatability of 3% scale, over a fan operating range of 6 to 1 capacity turndown. The station shall not induce a measurable pressure drop or increase the sound emitted by the system.
 - .4 A control panel shall be provided with an alpha numeric display of the air volumes and temperature of the points monitored. A keypad or PC link shall allow remote monitoring, trouble shooting or system reconfiguration.

2.12.33. Air Flow Stations (Duct Mount):

- .1 Fan air volume measuring device shall be either rectangular or round as indicated. Unit shall have 14 gauge galvanized sheet steel casing, flanged for installation to duct or plenum as applicable, with aluminum honeycomb equalizer and air straightening grid with copper static pressure sensors and total pressure sensors, installed in a grid pattern to provide total coverage of the device. Unit shall be capable of reading volumes within 1% for a velocity range of 800 to 4000 feet per minute (4 to 20 m/s).
- .2 Velocity pressure transmitter shall be selected to suit the system working pressures and shall meet the following performance requirements:
 - .1 Calibrated Accuracy: +/- 0.25% of span.
 - .2 Repeatability: 0.05% of output.
 - .3 Dead band & hysteresis: Not detectable.
- .3 Square root extractor and multiplier shall meet the following performance requirements:
 - .1 Calibrated Accuracy: +/- 0.5% of flow.
 - .2 Hysteresis: Not detectable.
 - .3 Repeatability: 0.05% of output.
 - .4 Response: 0.5 seconds.
 - .5 Multiplier: Adjustable 0.3 to 2.8.
- .4 Control panel shall be industrial standard wall mounted and shall contain all control equipment. Each panel shall have a hinged door, latch and lock.
- .5 Flow measuring device and velocity pressure transmitter shall be Air Monitor Corporation Fan-Evaluator and Veltron II.
- .6 Acceptable equal shall be Ebtron Gold Series:
 - .1 Each thermal flow sensor shall contain two individual sensing elements. One element shall determine velocity and the other shall provide a reference signal to the velocity sensor to compensate for temperature in the air flow. Each flow sensor shall operate independently and shall not affect any other flow sensors in the stations.
 - .2 Thermal flow sensor operation shall not be affected by dust particles in quantities typical to HVAC applications. The thermal flow sensors shall be mounted in aluminum probes for duct mounting and adjustable steel struts for fan inlet mounting. The number of sensors and probes shall be selected to provide maximum accuracy.
 - .3 Individual flow sensors shall transmit digital flow/temperature information to a microprocessor based control panel which shall total/average signals and output flow signals L/S (CFM) to the host DDC panel. The signals shall be linear 0 to 10 VDC or 4 to 20 mA. The velocity linearity shall be 2% of reading, with a repeatability of 3% of scale, over a fan operating range of 6 to 1 capacity turndown. The station shall not induce a measurable pressure drop or increase the sound emitted by the system.
 - .4 A control panel shall be provided with an alphanumeric display of the air volumes and temperatures of the points monitored. A keypad or P.C. link shall allow remote monitoring, trouble shooting or system reconfiguration.

2.13. WIRE AND CONDUIT

- 2.13.1. Conduit: Electrical metallic tubing EMT with compression type fittings in dry locations; cold rolled steel zinc coated or zinc coated rigid steel with threaded fittings in wet locations or where exposed to weather.
- 2.13.2. Outlet boxes: Dry locations: sherardized or galvanized drawn steel 100 mm (4 in.) square or octagon with suitable raised cover; Exposed to Weather: threaded hub cast aluminum boxes with gasket plate.
- 2.13.3. Junction boxes: Sized according to number, size and position of entering raceway; type: suitable for the environment.
- 2.13.4. Wire:
 - .1 Network:
 - .1 Per base building network requirements, coordinate with Owner/network manager
 - .2 If applicable, refer to Division 27
 - .2 Analog Input, Output: Stranded 18 gauge copper twisted shielded.
 - .3 Binary Input, Output: 18 gauge, minimum insulation rating of 600 volts.
 - .4 Class 2: FT-6 without conduit in ceiling plenums; FT-4 in conduit for all other cases.
 - .5 Plenum rated wiring to be used.

3. Execution

3.1. GENERAL

- 3.1.1. Install all controllers, cabinets, control devices and power supplies in readily accessible locations providing adequate ambient conditions for its specified application and to the Canadian Electrical Code.
- 3.1.2. Install Products to manufacturer's installation instructions.
- 3.1.3. Install parallel to building walls and floors unless indicated or specified or required by manufacturer's installation instructions.
- 3.1.4. Mechanical Contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.

3.2. COORDINATION

- 3.2.1. Submittals: To Part 1: General, Submittals.
- 3.2.2. Integrate and coordinate Work under this section to controls and control devices provided or installed by others.
- 3.2.3. Each Supplier of control Product to configure, program, start-up and commission that Product to satisfy requirements of Sequence of Operation regardless of where within Contract Documents Product is described or specified.
- 3.2.4. Resolve compatibility issues between control Product provided under this section and those provided under other sections or divisions of this Specification.

3.3. EXISTING PRODUCTS

- 3.3.1. This scope only applies to the Products that have become redundant as a result of this scope

- 3.3.2. Performance: During construction check and verify reused existing Products are operational. For existing Product that is not operational submit a proposal to replace existing Product for approval by the Consultant. Generally, Products which will potentially become redundant as a result of this scope of Work will only be reused if it meets the standards of this Specification.
- 3.3.3. Existing Products: Existing products are not approved for reuse under the Work..
- 3.3.4. Existing Wiring: Neatly coil, cap, identify and contain unused within cabinet(s).
- 3.3.5. Existing Cabinets: Remove from site and discard.
- 3.3.6. Existing Sensor Wells: Reuse, modify for proper fit and function.
- 3.3.7. Existing Electric Thermostats: Remove from site and discard.
- 3.3.8. Existing Sensors and Transmitters: Remove from site and discard.
- 3.3.9. Existing DDC Controllers: Remove from site and discard.
- 3.3.10. Existing Dampers, Electric Damper Actuators and Linkages: Remove from site and discard.
- 3.3.11. Existing Control Valves and Electric Valve Actuators: Remove from site and discard.
- 3.4. WIRING AND CONDUIT
 - 3.4.1. Wire shall be neatly tie wrapped to conduit mounted to the building structure but must be installed at right angles or parallel to the building. Loose wiring shall only be allowed over a distance of 1500 mm (5 ft.) but must not pass over lighting fixtures.
 - 3.4.2. Wiring in Equipment Room, between floors, or between concrete walls shall be installed in conduit. Exposed wiring will not be accepted. Conduit shall be installed at right angles or parallel to the building walls.
 - 3.4.3. Should it become necessary to splice field wiring it shall be soldered. If soldering is not possible, approved B type crimp connectors are an acceptable alternative. Wire nuts and Marr connections are not acceptable. Provide a 500 mm (20 in.) loop length at all splices.
 - 3.4.4. Conceal conduit within finished shafts, ceilings, and walls as required. Install exposed conduit parallel with or at right angles to the building walls.
 - 3.4.5. Plug or cap unused conduit openings and stubs with compatible fittings.
 - 3.4.6. Route all conduit to clear beams, plates, footings and structural members except through column footings and grade beams.
 - 3.4.7. Provide watertight seals at penetrations through outside foundation walls.
 - 3.4.8. Support conduit 25 mm (1 in.) and smaller to the building with one-hole non-perforated malleable iron or steel pipe straps. Suspend conduits larger than 1 in. on pipe racks with splitting hangers and rods.
 - 3.4.9. Maintain caps on conduit openings throughout construction.
 - 3.4.10. Where conduit is attached to vibrating or rotating equipment, install and anchor flexible metal conduit with a minimum length of 450 mm (18 in.) and a maximum length of 900 mm (36 in.) in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.
 - 3.4.11. Where exposed to weather or in damp or wet locations, provide waterproof flexible conduit.
 - 3.4.12. Fill conduit to maximum of 60% of its capacity. Provide a pull rope within the conduit when the installation is complete. Bend conduit to a radius of greater than 3 times the conduit diameter to a maximum of three 1/4 bends permitted between pull boxes.
 - 3.4.13. Wire within cabinets shall be installed in a plastic tray with a cover. Terminate wires to field-removable, modular terminal strips.

- 3.4.14. All field sensors shall be provided with a flexible conduit connection minimum length of 450mm (18 in.) and an enclosure for the electrical connections.
- 3.5. POWER WIRING
- 3.5.1. Power for section 23 09 00.00 - Building Automation System (BAS) shall be provided under Electrical Division 26 at 120 VAC 60 Hz single phase and shall terminate in junction boxes installed where shown on Electrical and/or Mechanical Drawings. Wiring and conduit from these boxes to control devices being electrically powered to be provided by section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- 3.5.2. Where power for equipment is fed from MCC, 120 VAC power for Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS) shall also be fed from the MCC from the 120 VAC section. Wiring and conduit from the MCC to control devices being electrically powered to be provided by section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- 3.6. COMMUNICATION WIRING
- 3.6.1. Install communication wiring per controls manufacturer recommendations as to type of wire used and segment lengths.
- 3.6.2. Install communication wiring in conduit and raceways separated from other wiring.
- 3.6.3. Verify entire network's integrity following cable installation using appropriate tests for each cable.
- 3.6.4. Each run of communication wiring to be continuous length without splices.
- 3.1.34. Provide data cables in conduit back to the closest data/telecom closet/room to allow all BAS head end equipment to connect to the network and all BAS controllers in the building as applicable to the project.
- 3.1.35. Ensure data cables are coordinated with requirements of BAS equipment based on submitted Shop Drawings.
- 3.6.5. Graphics: Generate graphic representations for systems under Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS and as follows:
- .1 Building elevation in three dimensions; indicate: floors and mechanical rooms.
 - .2 Floor plans: Indicate: Equipment rooms; point object data for temperature, humidity and pressure. Directly access graphic representation for terminal systems.
 - .3 Equipment Rooms: Indicate locations for systems.
 - .4 Systems: Indicate: Equipment, service connections, point object data, set points, reset schedules. Highlight point objects under operator command.
 - .5 Graphic representations link to and display graphic representations for associated systems.
- 3.7. CONTROL DEVICES
- 3.7.1. Provide or furnish control devices as indicated on the Drawings and to the requirements of this Section and to execute sequence of operation under Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS.
- 3.7.2. Provide or furnish control devices as indicated on the Drawings and to the requirements of this Section and to execute sequence of operations.
- 3.7.3. Motor Operated Dampers (Insulated and Uninsulated):

- .1 Furnish motor operated dampers for installation under Section 23 31.13.00 - DUCTWORK AND SPECIALTIES. Provide supervision on site during installation.
 - .2 Install in areas maintained above freezing.
 - .3 Install insulated motor operated dampers on all systems that connect with (or transfer air to/from) the exterior ambient environment and operate intermittently (i.e. time of day schedule, temperature sensor controlled, etc.).
- 3.7.4. Actuators for Dampers, Electronic:
- .1 Mounting: Direct coupled to drive shaft or jackshaft using a V bolt design.
- 3.7.5. Combination Smoke and Fire Damper and Smoke Damper Positions:
- .1 Monitor the positions of combination smoke and fire dampers and smoke dampers (e.g. open or closed) on the BAS based on damper end switches. Combination smoke and fire dampers, smoke dampers, and end switches are provided under Section 23 31 13.00 – DUCTWORK AND SPECIALTIES. Coordinate termination of wires with Fire Alarm Contractor, as the fire alarm system will also be monitoring the damper positions.
- 3.7.6. Control Valves:
- .1 Furnish control valves for installation under Section 22 11 13.00 - PIPE, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide supervision on site during installation.
- 3.7.7. Actuators for Control Valves, Electronic:
- .1 Factory install or field install actuator to valve body.
 - .2 Low Limit Electromechanical Thermostat:
 - .3 Install hardwire interlocked to supply fan starter for respective system.
 - .4 Provide according to Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS.
 - .5 Shut down the fan when duct temperature is equal to or less than 1.67 deg. C (35 deg. F).
 - .6 Install to adequately cover potential areas of low level stratification. Provide one low-limit thermostat for each 2.8 sq M (25 sq ft) of duct cross section. Mount sensing element on plastic clips.
- 3.7.8. High Limit Electromechanical Thermostat:
- .1 Install hardwire interlocked to fan starters for respective system.
 - .2 Shut down the fans when duct temperature is equal to or greater than 51.7 deg. C (125 deg. F).
 - .3 Provide one high-limit thermostat for each 3.7 sq M (40 sq ft) of duct cross section.
- 3.7.9. Electromechanical Thermostats and Temperature Sensors:
- .1 Furnish sensing wells for installation under Section 22 11 13.00 - PIPE, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide supervision on site during installation.
 - .2 Samples: Provide for wall mount type to Part 1: Submittals, Samples.
 - .3 Wall Mount Type:
 - .1 Cover Colour: White.
 - .2 Install to furred-in columns and permanent walls on concealed junction boxes supported by wall framing or surface mount 1.2 m (4 ft) above finished floor. Installation to mobile and temporary partitions is not acceptable.

- .3 Installation to exposed architectural concrete columns and walls is not acceptable, unless otherwise indicated or specified. For installation to concrete, set conduit in place before pouring of concrete.
- .4 Single Point Type, Duct:
 - .1 Provide sufficient contact with process fluid to measure average conditions.
 - .2 Apply pipe sealing compound to plug thread.
- .5 Single Point Type, Pipe:
 - .1 Provide sufficient contact with process fluid to measure average conditions.
 - .2 Install with heat conducting fluid in wells.
- .6 Outdoor Type:
 - .1 Install to north side of building away from sources of heat such as lamps and exhaust vents; to greater than 1500 mm (5 ft) above horizontal surfaces.
 - .2 Where indicated or specified for installation in outside air intake, locate so as not to be affected by exhaust air flow or reverse flow.
 - .3 Provide solar shield. Install shield to open downward.
 - .4 Seal interior of conduit at penetration through exterior wall.
- 3.7.10. Guards for Thermostats and Temperature Sensors:
 - .1 Provide for wall mount sensors and thermostats where indicated on the Drawings.
 - .2 Samples: Provide to Part 1: Submittals, Samples.
- 3.7.11. Air Static Pressure Sensors:
 - .1 Duct Mount: Pipe the high-pressure tap to the duct using a pitot tube.
 - .2 Building Static: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building and install with a shielded static air probe to reduce pressure fluctuations caused by wind.
 - .3 The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
- 3.7.12. Wet/Wet Differential Pressure Sensors:
 - .1 Differential pressure sensors shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
- 3.7.13. Relative Humidity Sensors:
 - .1 Install to requirements for Electric Thermostats and Temperature Sensors.
- 3.7.14. AC Current Sensors and Transducers:
 - .1 Install in motor starter cabinet.
- 3.7.15. CO Sensors:
 - .1 Mount the sensor between 900 mm (35.44 in.) and 1200 mm (47.24 in.) above finished floor.
 - .2 For parking garage applications, set low limit at 50 ppm and high limit at 100 ppm.
 - .3 Provide sufficient number of sensors for full coverage of the monitored area.
- 3.7.16. NO2 Sensors:
 - .2 Use two sensors per zone, mount one of the sensors 305 mm (1 ft.) from the floor and the other 305 mm (1 ft.) from the ceiling.

- .1 For parking garage applications, set low limit at 1 ppm and high limit at 3 ppm.
- .2 Provide sufficient number of sensors for full coverage of the monitored area.
- 3.7.17. Water Flow Meters and BTU Meters:
 - .1 Install the meter in either the supply or return pipe of the system to be measured following the manufacturer's written instructions.
 - .2 Provide isolation valves upstream and downstream of the meter.
 - .3 Provide suitable mating flanges and any required reducer/expander.
- 3.7.18. Gas Meter Connection:
 - .1 This Contractor shall provide connection from BAS to standard output of a gas meter transducer provided by local authorities.
- 3.7.19. Air Flow Sensors, Fan Bell Mouth:
 - .1 Coordinate installation of air flow sensors to inlet of fans with fan manufacturer.
- 3.7.20. Refrigerant Gas Detection System:
 - .1 Provide complete and operational system in accordance with CSA B52 "Mechanical Refrigeration Code."
 - .2 Provide refrigerant vapour detector(s) in areas where refrigerant from a leak is most likely to concentrate and have detectors activate at a value no greater than the corresponding Occupational Exposure Limit (OEL), 25% of the Lower Flammability Limit (LFL), or ammonia limits described in CSA B52.
 - .3 Provide multiple detectors where leaks are likely to concentrate in multiple locations including but not limited to:
 - .1 High and Low elevations where multiple refrigerants may stratify to different heights.
 - .2 At each ventilation exhaust inlet where airflow patterns direct leaks to multiple locations.
 - .4 Provide remote annunciator panels outside of each entrance to the Mechanical Room.
- 3.7.21. Air Flow Sensors, Duct Mount:
 - .1 Furnish duct mount air flow sensors for installation under Section 23 31 13.00 - DUCTWORK AND SPECIALTIES. Provide supervision on site during installation.
- 3.8. IDENTIFICATION
 - 3.8.1. All wires shall be tagged at both ends. The tagging shall identify the device it is connected to. Use of the point object name is acceptable.
 - 3.8.2. All wires passing through a junction box shall be tagged with the device identity or its termination point.
 - 3.8.3. The junction boxes shall be tagged "BAS" with a sequential number suffix.
 - 3.8.4. Label wires, control devices, controllers.
- 3.9. TESTING AND COMMISSIONING
 - 3.9.1. Test and commission the BAS prior to the Demonstration and Acceptance Test.
 - 3.9.2. Test and commission the BAS prior to the Demonstration.
 - 3.9.3. Prepare test forms which shall identify each test. The forms shall be sub-divided into:

- .1 points, controllers
 - .2 programs, loops networks and graphics.
- 3.9.4. Upon completion of the installation, the Control System Contractor shall load all system software and start-up the system. The Control System Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these Specifications.
- 3.9.5. Device tests shall identify and confirm successful completion of the following:
 - .1 Device installation.
 - .2 Device identification.
 - .3 Device calibration.
 - .4 Device operation.
 - .5 Wiring to device, connection details and wire type.
 - .6 Validation of the device signal at the controller.
- 3.9.6. Controller tests shall identify and confirm successful completion of the following:
 - .1 Controller installation.
 - .2 Power source and grounding.
 - .3 Make, model and serial number, software revisions.
- 3.9.7. Software tests shall identify and confirm successful completion of the following:
 - .1 Custom application programs.
 - .2 Alarm reporting.
 - .3 Trending and reports.
 - .4 Energy management programs.
- 3.9.8. Loop tuning tests shall identify and confirm successful completion of the following:
 - .1 Loop input signal.
 - .2 Loop output signal.
 - .3 Set point adjustment.
 - .4 Device response.
 - .5 Control response.
- 3.9.9. Network communication tests shall identify and confirm successful completion of the following:
 - .1 Primary network communication function.
 - .2 Secondary network communication function.
 - .3 Alarm reporting function.
 - .4 Operator communication.
- 3.9.10. Dynamic graphics tests shall identify and confirm successful completion of the following:
 - .1 All graphics.
 - .2 All point objects per graphic.
 - .3 All set-points per graphic.

3.10. DEMONSTRATION

- 3.10.1. When all tests have been completed and the documentation completed, request a meeting with the Consultant and Owner. Provide at this meeting a demonstration that all systems on the BAS are operating. At the successful conclusion of this demonstration the Consultant will allow the Acceptance Test to begin.
- 3.10.2. When all tests have been completed and the documentation completed, request a meeting with the Consultant and Owner. Provide at this meeting a demonstration that all systems on the controls are operating.
- 3.10.3. At the discretion of the Consultant and Owner, demonstrate up to 10% of the tests described in Part 3: Execution, Testing and Commissioning and witnessed by the Consultant and Owner. Should any test fail then the BAS Contractor shall retest the failed components or functionality.

3.11. BAS MAINTENANCE AND SERVICE (ALTERNATIVE PRICE) INCLUDE IN BID FORM.

- 3.11.1. Provide full BAS maintenance and service for one year after the warranty expires.
- 3.11.2. Assign a fully trained BAS service technician to perform all contract activities as described below with one backup person.
- 3.11.3. Service to include but not to be limited to: full day site visit once a week to perform system maintenance and service Work that is not urgent, including preparation of the visit report.
- 3.11.4. Scheduled preventive maintenance inspections will provide those services required to maintain the system at maximum performance and reliability levels and may include, but not be limited to the following: analyze, adjust, calibrate all sensors, diagnostic LEDs, printers, power supplies, work stations, controllers, input/output points, communication cabling, transmitters, transducers, damper and valve actuators, instrumentation and accessories directly pertaining to the Building Automation System.
- 3.11.5. Conduct inspections and thorough preventive maintenance routine on each piece of covered equipment. In addition, make tests and adjustments to ensure efficient and reliable operation of other major components.
- 3.11.6. Check and confirm control system sequence of operation to insure optimum system efficiency and economy. Monitor the operation of all systems connected to BAS and optimize the operation of those systems for better comfort and energy savings over the duration of operation and service contract.
- 3.11.7. Prepare a report on system operation once a month.
- 3.11.8. A log of each loop tested and each control sequence verified shall be reviewed with the Owner.
- 3.11.9. As part of the service, provide 24/7 contact number for service calls. Maximum response time to be 4 hours.
- 3.11.10. Provide a price for a one-year service agreement based on the above requirements to come in to effect upon the completion of the warranty period. Show this price as separate line item: Service Agreement.
- 3.11.11. Not included in the contract is the following: any customer initiated changes and additions to the system

END OF SECTION

23 09 23.00 Sequence of Operation for BAS

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and SECTION 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).

1.1.2. The locations of all sensors shall be discussed with and approved by the Owner and/or Engineer's Representative, before installation. Locations shown are approximate only, and are given to assist the Contractor in pricing only, and shall not be construed as being the final approved location.

1.1.3. The control sequence descriptions are complementary. Provide detailed sequences of operation and all points required to implement the sequences.

1.1.4. All settings and set points listed in this Section shall be variable and Operator adjustable without the need to create or modify Custom Application Programs.

1.1.5. All set points and reset schedules shall be visual on the associated dynamic graphic.

1.1.6. Where the project includes an existing BAS, ensure that any upgrades to the existing BAS for this project scope does not negatively impact existing BAS infrastructure. Maintain the functionality of existing controls not revised by this scope of work.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. GENERAL APPLICATION PROGRAMS

2.1.1. Provide a specific set of programs to achieve automated, operator independent control of facility sub-systems.

2.1.2. Refer to SECTION 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS) for software programs.

3. Execution

3.1. GENERIC THERMAL ZONES

3.1.1. Applicable Systems:

- .1 Single zone systems
- .2 VAV boxes
- .3 Fan-powered boxes

3.1.2. Setpoints

- .1 Provide zone temperature setpoints as follows:

Zone Type or Name	Occupied Heating	Occupied Cooling	Unoccupied Heating	Unoccupied Cooling
VAV	22 deg. C	24 deg. C	16 deg. C	32 deg. C
Fan-Powered Boxes	22 deg. C	24 deg. C	16 deg. C	32 deg. C
Fan Coils	22 deg. C	24 deg. C	16 deg. C	32 deg. C
Residential Suite	22 deg. C	24 deg. C	20 deg. C	26 deg. C
Gymnasium	20 deg. C	20 deg. C	18 deg. C	26 deg. C
Pool	29 deg. C	29 deg. C	29 deg. C	29 deg. C
Pool Change Room	26.5 deg. C	26.5 deg. C	26.5 deg. C	26.5 deg. C
Arena	15.5 deg. C	15.5 deg. C	12 deg. C	15.5 deg. C
Arena Change Room	22 deg. C	22 deg. C	15 deg. C	22 deg. C
Mech/Elec Rooms	18 deg. C	30 deg. C	18 deg. C	30 deg. C
Networking/IT Rooms	18 deg. C	24 deg. C	18 deg. C	24 deg. C

- .2 Determine the active setpoint by the operating mode of the zone group.
 - .1 Provide the occupied set points during occupied mode, warm-up mode, and cooldown mode.
 - .2 Provide the unoccupied set points during unoccupied mode, setback mode, and setup mode.
- .3 Provide zone relative humidity setpoints as follows:

Zone Type or Name	Occupied Heating	Occupied Cooling	Unoccupied Heating	Unoccupied Cooling
VAV	__% RH	__% RH	__% RH	__% RH
Fan-Powered Boxes	__% RH	__% RH	__% RH	__% RH
Fan Coils	__% RH	__% RH	__% RH	__% RH
Residential Suite	__% RH	__% RH	__% RH	__% RH
Gymnasium	__% RH	__% RH	__% RH	__% RH
Pool	60 % RH	60 % RH	50 % RH	50 % RH
Arena	1.7 deg. C dew point	1.7 deg. C dew point	1.7. deg. C dew point	1.7 deg. C dew point

- .4 Provide zone CO2 concentration setpoints as follows:

Occupancy Category	CO2 Setpoint (ppm)	Occupancy Category	CO2 Setpoint (ppm)
Daycare	1,000	Office Space	900
Classroom (age 5-8)	850	Reception	1,650
Lecture Classroom	1,305	Conference/Meeting	1,600
Restaurant/Dining	1,400	Lobby/Prefunction	1,500
Breakrooms	1,200	Library	800
Retail	1,050	Health Club (Aerobics)	1,700
		Health Club (Weights)	1,200

3.2. DOMESTIC HOT WATER TANKS AND RECIRCULATION PUMP

3.2.1. Normal Operation:

- .1 The BAS shall monitor each domestic hot water tank temperature.

- .2 The controls provided with each domestic hot water tank shall maintain tank temperature set-point.
 - .3 The BAS shall modulate the domestic water mixing valve to maintain the domestic hot water supply temperature.
 - .4 During occupied hours, domestic hot water recirculation pump shall run continuously.
 - .5 The BAS shall monitor the DHW supply temperature at the outlet of the tank and at a remote location downstream in the domestic water system as indicated on site by the Consultant.
 - .6 During unoccupied hours, the BAS shall start the domestic hot water recirculation pump when the remote supply temperature falls below the minimum supply water set-point (initially set at 37.8 deg. C. (100 deg. F.)).
 - .7 The BAS shall stop the domestic hot water circulator when the remote temperature is maintained at a minimum of 51.7 deg. C. (125 deg. F.) for 10 minutes.
- 3.2.2. Alarms:
- .1 Domestic Water Recirculation Pump (DWRPST) from current sensor.
 - .2 Domestic Hot Water Tank Temperature (DHWTT) out of range.
 - .3 Domestic Hot Water Supply Temperature (DHWST) out of range.
- 3.3. ERV UNIT CONSTANT VOLUME
- 3.3.1. Applicable Systems: ERV-1
- 3.3.2. System Start:
- .1 The ERV shall be started based on schedule or by operator command at the BAS terminal.
- 3.3.3. Normal Operation:
- .1 ERV shall run continuously during occupied hours.
- 3.3.4. System Stop:
- .1 System stop shall be initiated by schedule or by operator command at the BAS.
- 3.3.5. Alarms:
- .1 Supply Fan Status (SFST) from current sensor.
 - .2 Exhaust Fan Status (EFST) from current sensor.
- 3.4. EXHAUST FAN
- 3.4.1. Applicable Systems: EF-1, EF-2
- 3.4.2. System Start:
- .1 System start shall be initiated by space temperature demand or through time schedule. Upon signal to start the system, the exhaust damper shall open, when the damper end switch makes, the fan shall start.
- 3.4.3. Normal Operation:
- .1 Exhaust fan shall cycle to maintain Space Temperature (SPCT) at set-point (adjustable), or shall run continuously during occupied hours.
- 3.4.4. System Stop:

- .1 System stop is initiated when space temperature is satisfied or through time schedule. Upon signal to stop the system, the exhaust fan shall stop and the exhaust damper shall close.

3.4.5. Schedule:

- .1 To be determined by the Owner.

3.4.6. Alarms:

- .1 Exhaust Fan Status (EFST) from current sensor.
- .2 Space Temperature (SPCT) out of range.

3.5. HEATING WATER PLANT WITH TWO BOILERS(EXISTING) AND GLYCOL HEAT EXCHANGER

3.5.1. System Start:

- .1 Lead/lag pump P-HTG-1/2 shall be enabled when Outside Air Temperature (OAT) is less than -5°C (23 deg. F) for more than 30 minutes.
- .2 The Glycol Pump (P-HTG-3/4) and Glycol Control Valve (GCV) shall be enabled when P-HTG-1/2 is enabled.
- .3 H

3.5.2. Normal Operation:

- .1 The lead Hot Water Secondary Pump (HWSP) shall run continuously when the outside air temperature is below system enable set-point.
- .2 The lead boiler primary pump shall start and when the flow is proven, the lead boiler shall modulate to maintain Hot Water Supply Temperature (HWST) at set-point based on Outside Air Temperature (OAT) as per following:

Outdoor Air Temperature (OAT)	12.8°C (55 deg. F)	-15°C (5 deg. F)
Hot Water Supply Temperature (HWST) Set-Point	43.3°C (110 deg. F)	82.2°C (180 deg. F)

- .3 The lag boiler and its pump shall be enabled if system load requires the second boiler.
- .4 Lead and lag boilers shall change on a weekly basis.
- .5 The lead glycol pump shall run continuously when the system is enabled. Lead and lag glycol pumps shall change on a weekly basis.
- .6 Glycol Control Valve (GCV) shall modulate to maintain Glycol Supply Temperature (GLYST) at set-point.

3.5.3. System Stop:

- .1 The system shall be disabled when Outside Air Temperature (OAT) rises above 18.3°C (65 deg. F).

3.5.4. Alarms:

- .1 Boiler General Alarms (BGAL) from boiler panels.
- .2 System pumps (PST) from current sensors.
- .3 Hot Water Supply Temperature (HWST) out of range.
- .4 Hot Water Return Temperature (HWRT) out of range.
- .5 Glycol Supply Temperature (GLYST) out of range.

.6 Glycol Return Temperature (GLYRT) out of range.

3.6. LIGHTING CONTROL

3.6.1. Applicable Systems:

3.6.2. System Start:

.1 Lighting zones shall be activated through time schedule.

3.6.3. Normal Operation:

.1 Lighting zones shall be on during occupied hours.

3.6.4. System Stop:

.1 Lighting zones shall be deactivated through time schedule.

.2 Lighting zones can be overridden on by a local override switch for an adjustable time period.

3.6.5. Schedule:

.1 To be determined by the Owner.

3.6.6. Alarms:

.1 Lighting Zone Status.

3.7. MISCELLANEOUS MONITORING POINTS (CONTROL DIAGRAM CDXX)

3.7.1. Miscellaneous Points:

.1 Outdoor Air Temperature.

.2 Fire Pump.

.3 Fire Alarm.

.4 Compressor Status.

.5 Compressed Air Pressure.

.6 Domestic Water Pump.

.7 Domestic Water Pressure.

.8 OEM Control Panel General Alarm.

.9 Gas Meter.

.10 Water Meter, main and tenant.

.11 Energy Meter.

.12 Cooling Tower Make-Up.

.13 Steam Boiler Make-Up.

.14 Steam Pressure.

.15 Electrical Meter.

.16 Sump Water Level.

.17 Sump Pump.

3.8. RTU CONSTANT VOLUME 100% OUTSIDE AIR WITH HEAT WHEEL

3.8.1. Applicable Systems: RTU-1, RTU-2

3.8.2. System Start:

- .1 System start is initiated by operator command at the BAS or through time schedule. Upon signal to start the system, Exhaust Air Damper opens (EAD). Open position end switch (EADES) enables exhaust fan to start when exhaust air damper is fully opened. Exhaust Fan starts (EFSE) with the VSD at minimum position and a time delay of 30 seconds is initiated before the supply fan start signal is initiated. Upon the signal to start the supply fan, Outdoor Air Damper opens (OAD). Open position end switch (OADES) enables the supply fan to start when outdoor air damper is fully opened with the VSD at minimum position.
- .2 DX Cooling, Heat Pump and Heat Wheel shall be enabled when system fans are running.

3.8.3. Normal Operation:

- .1 The supply air static pressure control loop shall maintain the supply air static set-point of 0.3125 kPa (1.26 in. w.g.) by modulating the supply fan variable speed drive. The static sensor shall be located 2/3 down the supply ductwork.
- .2 The fan tracking control loop shall maintain the set-point air volume between the supply air and return air by modulating the return fan variable speed drive.
- .3 BAS shall modulate heat wheel speed through Heat Wheel Variable Speed Drive (HTWVSD) to maintain heat wheel Leaving Air Temperature (LAT) at 12.8°C (55 deg. F) (adjustable).
- .4 DX Cooling shall cycle to maintain Supply Air Temperature (SAT) at 12.8°C (55 deg. F) in cooling mode.
- .5 Heat pump shall cycle to maintain Supply air temperature (SAT) at 21.1°C (70°F). Glycol heating coil shall enable when ambient air temperature falls below -5°C (23°F) for greater than 5 minutes in heating mode.
- .6 Supply Air Humidity (SAH) and Return Air Humidity (RAH) shall be monitored by BAS.
- .7 Heat wheel frost control mode: if frosting conditions are calculated to occur using Return Air Humidity (RAH), Return Air Temperature (RAT), Outdoor Air Temperature (OAT) and Heat Wheel Leaving Air Temperature (HTWLAT), heat wheel speed shall be modulated to maintain Heat Wheel Leaving Air Temperature (HTWLAT) above calculated set-point.
- .8 Heat wheel standby mode: heat wheel shall be rotated at minimum speed one and a half rotation once per day when not in use.

3.8.4. System Stop:

- .1 System stop is initiated by operator command at the BAS or through time schedule. Upon signal to stop the system, the supply and exhaust fans shall stop. Outdoor and Exhaust Air Dampers (OAD, EAD) shall close. DX Cooling and Gas Heating shall be disabled. Heat Wheel (HW) shall be disabled.

3.8.5. Schedule:

- .1 System operates continuously.

3.8.6. Alarms:

- .1 Supply Fan Feedback (SFFB) from variable speed drive.
- .2 Exhaust Fan Feedback (EFFB) from variable speed drive.
- .3 Supply Fan VSD in manual override.
- .4 Exhaust Fan VSD in manual override.
- .5 Supply Air Temperature (SAT) out of range.
- .6 Safety alarms: low plenum air temperature (FZ), high plenum supply and exhaust air temperatures (F), high supply air static pressure (SAHP).

- .7 Supply and Exhaust Pre Filters (PFPD) dirty at 250 Pa (0.036 psi) pressure drop.

3.9. ELECTRIC FORCE FLOW HEATER

3.9.1. Applicable Systems: FFH-1, FFH-2, FFH-3

3.9.2. System Start:

- .1 System shall be enabled only in winter mode.
- .2 System start shall be initiated by space temperature demand. Upon signal to start the system, supply fan shall start. Heating coil valve shall be enabled.

3.9.3. Normal Operation Winter Mode:

- .1 Supply Fan (SFSS) shall cycle and resistive heating (HCV) shall modulate to maintain Space Temperature (SPCT) at set-point.

3.9.4. System Stop:

- .1 System stop is initiated when space temperature is satisfied. Upon signal to stop the system, the supply fan shall stop. Heating coil valve shall be closed.
- .2 System shall be disabled in summer mode.

3.9.5. Alarms:

- .1 Supply Fan Status (SFST) from current sensor.
- .2 Space Temperature (SPCT) out of range.

3.10. VRF FANCOIL SYSTEM WITH SUPPLEMENTARY HEATING

3.10.1. Applicable Systems: FCU-XX-XX, CU-X

3.10.2. System Start:

- .1 System start is initiated by operator command at the BAS, through normal time schedule or by input at the local controller

3.10.3. Normal Operation:

- .1 VRF Fan coils will provide primary source of heating and cooling depending mode of operation. Heat pump system to operate in specified mode heating or cooling based on outdoor air setpoint (adjustable).
- .2 When supplementary heating is enabled as determined by the local thermostat, the VRF controller shall enable the supplementary heating equipment to act as the second stage of heating. If the space temperature setpoint is not met in 5 minutes (adjustable), the perimeter heating control valve shall be modulated to maintain space temperature at setpoint. The VRF shall operate continuously during this time.

3.10.4. System stop:

- .1 System stop is initiated through a signal or time schedule.

3.10.5. Schedule:

- .1 To be determined by owner.

3.10.6. Alarms:

- .1 Space temperature out of range for greater than 10 minutes.

3.11.

END OF SECTION

23 21 13.23 Piping, Valves & Fittings (Except Plumbing)

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. All gate, globe and check valve shall be approved under Canadian Interprovincial Regulations for the Construction and Inspection of Boilers, Tanks, and Appurtenances.

1.1.3. Provide Shop Drawings in accordance with Section 20 05 03.00 - SHOP DRAWINGS for all valves, appurtenances, and grooved components.

1.1.4. All steel pipe and fittings shall be manufactured in North America. Off-shore pipe shall not be accepted on site. Pipe shall be clearly marked as being manufactured in North America or it shall be removed from site.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Use pipes, fittings and valves as shown below unless specifically shown or specified otherwise.

2.2. HIGH TEMPERATURE AND/OR PRESSURE WATER

2.2.1. High temperature heating water 121 deg. C. (250 deg. F.) at 1035 kPa (150 psi) and over, and heating water at 93.3 deg. C. (200 deg. F.) at 1138 kPa (165 psi) and over and chilled and condenser water less than 66 deg. C. (150 deg. F.) above 1380 kPa (200 psi).

2.2.2. Pipe 300 mm (12 in.) and larger, black steel ASTM A53, 12 mm (1/2 in.) wall, plain ends, ANSI B36.10.

2.2.3. Pipe 65 mm (2-1/2 in.) to 250 mm (10 in.), black steel ASTM A53, Schedule 80, plain ends, ANSI B36.10.

2.2.4. Pipe 50 mm (2 in.) and smaller, black steel ASTM A53, Schedule 80, threaded, ANSI B36.10.

2.2.5. Fittings 300 mm (12 in.) and larger, black steel ASTM A234, 12 mm (1/2 in.) wall, butt-welding, ANSI B16.9.

2.2.6. Fittings 65 mm (2-1/2 in.) to 250 mm (10 in.), black steel ASTM A234, Schedule 80, butt-welding ends, ANSI B16.9.

2.2.7. Fittings 50 mm (2 in.) and smaller, malleable iron ASTM A197, 2070 kPa (300 psi) WSP, threaded, ANSI B16.3.

2.2.8. Flanges 65 mm (2-1/2 in.) and larger, forged steel ASTM A181, 2070 kPa (300 psi) WSP ANSI B16.5. Use only weld neck flanges with butterfly valves.

2.2.9. Union 50 mm (2 in.) and smaller, malleable iron ASTM A197, 2070 kPa (300 psi) WSP, with bronze to iron ground joint, ANSI B16.3.

- 2.2.10. Flange accessories for high temperature hot water:
- .1 Gasket, 1.5 mm (1/16 in.) Asbestos free, Aramid fibres with nitrile binder suitable for 205 deg. C. (400 deg. F.) continuous maximum temperature at 6880 kPa (1000 psi), equal to Garlock Blue-Gard 3000.
 - .2 Bolts, alloy steel ASTM A193, ANSI B16.5, nuts, hexagonal, steel ASTM A307.
- 2.2.11. Strainers 65 mm (2-1/2 in.) and larger, cast iron 1720 kPa (250 psi) WSP flanged.
- 2.2.12. Strainers 50 mm (2 in.) and smaller, cast iron 1720 kPa (250 psi) WSP, threaded.
- 2.2.13. Gate valves 65 mm (2-1/2 in.) and larger, 2060 kPa (300 psi) WSP, cast steel O.S. and Y, ANSI B16.5 Flanges, shall be Crane #33XUF, Kitz 300 SCLS, Bonney Forge 3-11-RF, Beric 103RF, NCI #GF03RF or Jenkins J1010B8F.
- 2.2.14. Gate valves 50 mm (2 in.) and smaller, bronze 1380 kPa (200 psi) WSP, rising stem, threaded shall be Crane #424, Jenkins #2270UJ, Toyo 314, Beric 501T, NCI #GTVA-TBZ3333U or Kitz 37.
- 2.2.15. Globe valves 65 mm (2-1/2 in.) and larger, 2060 kPa (300 psi) WSP, cast steel metal disc, renewable seat, ANSI B16.5 Flanges, shall be Crane 151XU, Kitz 300 SCJS, Bonney Forge 3-31-RF, Beric 203RF, NCI #SL03RF or Jenkins J1042B2.
- 2.2.16. Globe valves 50 mm (2 in.) and smaller, bronze 1380 kPa (200 psi) WSP, renewable seat and plug, threaded shall be Crane #212P, Jenkins #2050J, Toyo 214, Beric 502T, NCI #GLBA-TBZ3443U or Kitz 17S.
- 2.2.17. Check valves 65 mm (2-1/2 in.) and larger, 2060 kPa (300 psi) WSP, cast steel, swing check, ANSI B16.5 Flanges, shall be Crane #159XU, Kitz 300SCOS, Bonney Forge 3-61-RF, Beric 303RF, NCI #CS03RF, or Jenkins J1025B2.
- 2.2.18. Check valves 50 mm (2 in.) and smaller, bronze 1380 kPa (200 psi) WSP swing check, threaded shall be Crane #36, Jenkins 4449J, Toyo 360, NCI #CKVA-TBZ3330 or Kitz 19.
- 2.2.19. Drain valves for blow-off of sediment from strainers, pipe drainage and tank drainage, shall be 19 mm (3/4 in.) size 250 WSP or 4130 kPa (600 psi) WOG ball valve with bronze body, stainless steel ball and stem, multifilled seats and packing, male threaded garden hose end, brass cap and chain shall be Apollo 70-140-64.
- 2.2.20. Butterfly valves maybe used as an alternative to gate valves only and shall be carbon steel body, one-piece shaft, top and bottom bearings, stainless disc with stainless steel trim with combination TFE and Titanium seat. Body with threaded lugs suitable for 2070 kPa (300 psi) flanges. Bubble-tight shut-off to 1965 kPa (285 psi) pressure in either direction when the piping and connecting flange is removed from one side of the valve.
- .1 Valves 100 mm (4 in.) and smaller with lever operator with lock. Valves 150 mm (6 in.) and larger with worm gear manual operator with indication of valve opening.
 - .2 Valves shall be shall be Dezurik Model BHP, WKM, Keystone Model K-LOK, Flowseal or Hills-McCanna Model McCannalock.
- 2.2.21. Butterfly valves maybe used as an alternative to gate valves only and shall be ANSI Class 300, carbon steel body, one-piece 17-4 shaft, top and bottom bearings, stainless disc, RTFE packing and seats. Body with threaded lugs suitable for 2070 kPa (300 psi) flanges. Bubble-tight shut-off to 5102 kPa (740 psi) pressure in either direction when the piping and connecting flange is removed from one side of the valve.
- .1 Valves 100 mm (4 in.) and smaller with lever operator with lock. Valves 150 mm (6 in.) and larger with worm gear manual operator with indication of valve opening.
 - .2 Valves shall be shall be WKM B5313-02-S02-11-HL, Flowseal 3DA121RTG-40J for lever operator and WKM B5313-02-S02-11-WG, Flowseal 3DA121RTG-30J for gear operator.

2.3. LOW TEMPERATURE AND/OR PRESSURE WATER

- 2.3.1. Heating water less than 121 deg. C. (250 deg. F.) at 1035 kPa (150 psi), or heating water less than 93.2 deg. C. (200 deg. F.) at 1139 kPa (165 psi), and chilled and condenser water less than 65.6 deg. C. (150 deg. F.) at 1380 kPa (200 psi).
- 2.3.2. Pipes 300 mm (12 in.) and larger, black steel ASTM A53, 9.5 mm (0.375 in.) wall, plain ends, ANSI B36.10.
- 2.3.3. Pipes 65 mm (2-1/2 in.) to 250 mm (10 in.) ASTM A53, Schedule 40, plain ends, ANSI B36.10.
- 2.3.4. Pipes 50 mm (2 in.) and smaller, black steel ASTM A53, Schedule 40, threaded, ANSI B36.10.
- 2.3.5. Pipes 100 mm (4 in.) and smaller, alternative for entire system for heating water, chilled water and condenser water in hard-tempered copper ASTM B88, Type L, plain ends. All joints made with 95-5 tin-antimony or tin-silver solder.
- 2.3.6. Pipe runouts to all induction and fan coil units and similar equipment soft temper copper ASTM B88, Type L, plain ends, size as shown, but minimum size of runouts 19 mm (3/4 in.). All joints made with 95-5 tin-antimony or tin-silver solder.
- 2.3.7. Fittings 300 mm (12 in.) and larger, black steel ASTM A234, 9.5 mm (0.375 in.) wall, butt-welding ends, ANSI B16.9.
- 2.3.8. Fittings 65 mm (2-1/2 in.) to 250 mm (10 in.) black steel ASTM A234, Schedule 40, butt-welding ends, ANSI B16.9.
- 2.3.9. Fittings 50 mm (2 in.) and smaller, malleable iron ASTM A197, 860 kPa (125 psi) WSP threaded, ANSI B16.3.
- 2.3.10. Flanges 65 mm (2-1/2 in.) and larger, forged steel ASTM A181, 1035 kPa (150 psi) WSP, ANSI B16.1. Use only weld neck flanges with butterfly valves.
- 2.3.11. Fittings alternative for entire system for heating water, chilled water and condenser water: wrought copper or cast bronze, solder, joint, ANSI B16.22.
- 2.3.12. Unions 50 mm (2 in.) and smaller malleable iron ASTM A197, 1035 kPa (150 psi) WSP, with bronze to iron ground joint, ANSI B16.3.
- 2.3.13. Flange accessories for heating water and condenser water:
 - .1 Gasket, 1.5 mm (1/16 in.) Synthetic fibres with rubber binder suitable for 205 deg. C. (400 deg. F.) continuous maximum temperature at 3440 kPa (500 psi), equal to Garlock Multi-Swell 3760.
 - .2 Bolts, hexagonal head machine with hexagonal nut, steel ASTM A307, ANSI B18.2.
- 2.3.14. Flange accessories for chilled water, gasket, cloth inserted rubber ring, bolts, hexagonal head machine with hexagonal nut, steel ASTM A307, ANSI B18.2.
- 2.3.15. Strainers 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, flanged.
- 2.3.16. Strainers 50 mm (2 in.) and smaller, cast iron 1720 kPa (250 psi) WSP, threaded.
- 2.3.17. Strainers 50 mm (2 in.) and smaller, for copper pipes bronze 860 kPa (125 psi) WSP, threaded. Mueller #351M.
- 2.3.18. Gate valves 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, bronze mounted, O.S. and Y ANSI B16.1 Flanges, shall be Crane #465 1/2, Jenkins #454J, Toyo 421, NCI #GTVA-FCI-1333HW or Kitz 72.
- 2.3.19. Gate valves 50 mm (2 in.) and smaller, bronze 1035 kPa (150 psi) WSP rising stem, threaded shall be Crane #431, Jenkins #2810J, Toyo 298, NCI #GTVA-TBZ2333 or Kitz 42.
- 2.3.20. Globe valves 65 mm (2-1/2 in.) and larger, cast iron 860 kPa (125 psi) WSP, bronze mounted, renewable composition disc, ANSI B16.1 Flanges shall be Crane #351, Jenkins #2342, Toyo 400A, NCI #GLBA-FCI-1333HW or Kitz 76.

- 2.3.21. Globe valves 50 mm (2 in.) and smaller, bronze 1035 kPa (150 psi) WSP, renewable composition disc, threaded shall be Crane #7TF, Jenkins #106-B, Toyo 221, NCI #GLBA-TBZ2360 or Kitz 9.
- 2.3.22. Butterfly valves maybe used as an alternative to gate valves only and shall be iron body, one-piece alloy steel shaft, top and bottom bearings, bronze disc or iron disc with stainless steel trim, resilient elastomer replaceable seat with integral reinforcing ring or keyed to body. Body with threaded lugs. Bubble-tight shut-off to 1035 kPa (150 psi) pressure in either direction when the piping and connecting flange is removed from one side of the valve.
- .1 Valves 100 mm (4 in.) and smaller with lever operator with lock.
 - .2 Valves 150 mm (6 in.) and larger with worm gear manual operator with indication of valve opening.
 - .3 Butterfly valves shall be shall be DeZurik Model BGS, Keystone Model 222-784, Bray Series 31, Challenger Model 20-CN4E, Apollo 143, Kitz 6122EL/G, Centerline 200, or Crane 44.
- 2.3.23. Check valves 50 mm (2 in.) and smaller bronze 860 kPa (125 psi) WSP, swing check, screwed cover, screwed shall be Crane #37, Jenkins #4092, Toyo 236, NCI CKVA-TBZ2331 or Kitz 22.
- 2.3.24. Check valves 65 mm (2-1/2 in.) and larger ANSI Class 150, 1030 kPa (150 psi) WSP, dual flapper retainers design with carbon steel body and stainless steel check, renewable disc and seat for flanged installation, shall be Velan-Proquip model BDD10-1B or DUO CHEK II H15SMF-201, NCI/SSI #150WTCT, or Mueller 72-DHH-3-H.
- 2.3.25. Drain valves for blow-off of sediment from strainers and tank drainage shall be 19 mm (3/4 in.) size 4140 kPa (600 psi) WOG ball valve with bronze or forged brass body, solid ball, virgin Teflon seat and packing, male threaded garden hose end, brass cap and chain shall be Watts B6000, Toyo 5046, Kitz 58CC or Apollo 78-100.
- 2.3.26. Float type eliminators, designed for a minimum of 1035 kPa (150 psi) water pressure with steel or cast iron body having removable flanged top, stainless steel or copper float and stainless steel valve and level mechanism.
- 2.3.27. As an alternative on vertical in-line pumps suction elbow may be combination elbow and strainer. Strainer perforations shall be as specified for Y strainers. Blow-off valves shall be provide in all sizes. Sizes of elbow strainer shall suit the pump suction size. Elbow shall be cast iron. Elbow shall be sized to suit pipe.
- 2.3.28. Radiation and fan coil shut off valves shall be Dahl Model 11042FXUN radiator valve suitable for 1720 kPa (250 psi) at 121 deg. C. (250 deg. F.). Lockshield balance valves shall be Dahl Model 13.013M.
- 2.3.29. Ball valves for heating water and chilled water 50 mm (2 in.) and smaller shall be bronze body 4140 kPa (600 psi) WOG, virgin Teflon seat, solid ball, TFE stem packing and thrust washer, 1/4 turn open-closed operation. All components to be replaceable in-line. Solder end valves are not acceptable. All ball valves shall be complete with stem extensions. Ball valves shall be Watts No. B-6800, Toyo 5050, Kitz 62, or Apollo 82-100-04.
- 2.3.30. Ball valves for heating water and chilled water 50 mm (2 in.) and smaller shall be bronze or forged brass 4140 kPa (600 psi) WOG, virgin Teflon seat, solid ball, TFE system packing and thrust washer, 1/4 turn open-close operation. All ball valves shall be complete with stem extensions. Ball valves shall be Watts B6000, Toyo 5044A, Kitz 58/59, NCI 600FP-T/600FP-S or Apollo 70-100/200-04.

- 2.3.31. Flow balancing valves shall have meter connection for attaching to a portable meter. Each connection shall have positive shut-off valves. Each valve shall be capable of precise flow measurement, accurate flow balancing and positive shut-off. Adjustment shall be by multiple turns of the handle for Vernier type setting and shall have a hidden memory feature for tamper-proof setting.
- .1 For all valves 65 mm (2-1/2 in.) and larger, provide flanged or grooved as follows: Flanged: Victaulic / TA Hydronics Series 788 flanged, Nexus UltraMB MBF, or IMI Hydronic Engineering STAF; Grooved: Victaulic / TA Hydronics Series 789 grooved, Nexus UltraMB MBG, or IMI Hydronic Engineering STAG.
 - .2 For valves 50 mm (2 in.) and smaller, provide screwed as follows: Victaulic / TA Hydronics Series 787, Nexus UltraMB, or IMI Hydronic Engineering STAD.
 - .3 Provide a portable flow measuring meter, complete with hoses and carrying case to suit each size of valve provided. Meter shall be computerized, differential pressure type for direct reading of flow rate in either GPM or L/s.
- 2.3.32. As an alternative to Standard Details (MSD-765.02) for reheat coil installation provide preassembled coil pipe and fitting assembly with flow balancing valve, unions, air vent, temperature and pressure port, and serviceable strainer with isolation valves. Victaulic Series 799 Koil-Kit complete with 78K-STADK flow balancing valve, 78-UP union plus air vent and PT port, and 78Y with 20 mesh Y-strainer/ball valve/drain & coil hoses or Red & White complete with 9517/9519 flow balancing valve, 92STC Combination ball valve, Y-strainer, drain & test port, 92UTFM brass union, air vent and PT port, SSB stainless steel flexible hoses. Automatic air vent piped to drain shall be used if branch take-off is above the main. Stainless steel hose sizes to be determined by Contractor. Coordinate control valve with Controls Contractor.
- 2.4. GROOVED PIPE AND FITTINGS
- 2.4.1. For systems less than 120 deg. C. (248 deg. F.) at 2068 kPa (300 psi) or as specified.
- 2.4.2. Grooved pipe and fittings may be used for hot water, chilled water, hot or chilled glycol, and condenser water systems.
- 2.4.3. Pipes 50 mm (2 in.) to 250 mm (10 in.) black steel ASTM A53, Schedule 40 cut or roll grooved.
- 2.4.4. Pipes 300 mm (12 in.) and larger black steel ASTM A53, 9.5 mm (0.375 in.) wall, cut or grooved.
- 2.4.5. Couplings shall consist of two ASTM A536 grade 65-45-12 ductile iron housing segments, ASTM D2000 pressure responsive elastomer gasket, and ASTM A449 zinc-electroplated steel bolts and nuts.
- .1 Sizes 300 mm (12 in.) and smaller:
 - .1 Rigid Type: Housings shall be cast with torque-absorber and shift-limiting slant bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9 and to prevent mis-assembly due to overshift.
 - .1 50 mm (2 in.) through 300 mm (12 in.): Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket rated to 121 deg C. (250 deg. F). Victaulic Style 107V.
 - .2 As an alternative provide Victaulic Zero-Flex Style 07.
 - .2 Flexible Type: For use in locations where vibration attenuation and stress relief are required or in a Victaulic riser design. Three flexible couplings may be used in lieu of a flexible connector. The couplings shall be placed in close proximity to the source of the vibration. Victaulic Style 177N or 77.

- .2 Size 350 mm (14 in.) and larger: Victaulic AGS Series with lead-in chamfer on housing key and wide width flush seal gasket.
 - .1 Rigid Type: Housing key shall fill the wedged shape AGS groove and provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style W07.
 - .2 Flexible Type: Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular deflection. Victaulic W77.
- 2.4.6. Fittings 50 mm (2 in.) to 250 mm (10 in.) cast ductile iron ASTM A536 grade 65-45-12.
- 2.4.7. Fittings 300 mm (12 in.) and larger full flow cast fitting. Factory fabricated steel fittings to ASTM Grade B may only be used with the approval of Engineer's Representative.
 - .1 350 mm (14 in.) and larger shall be complete with Victaulic 'AGS' grooved ends.
- 2.4.8. Branch connections: ductile iron ASTM A535; Victaulic Style 920, 920N, or 72.
- 2.4.9. Flanges; ductile iron ASTM A536 for sizes 50 mm (2 in.) to 600 mm (24 in.); Victaulic Style 741/W741.
- 2.4.10. Gaskets: EPDM conforming to ASTM D-2000, temperature range -34 deg. C. to 110 deg. C. (-30 deg. F. to 230 deg. F.).
 - .1 EHP conforming to ASTM D-2000, temperature range -34 deg. C to 121 deg. C. (-30 deg. F. to 250 deg. F.).
- 2.4.11. Valves 50 mm (2 in.) to 300 mm (12 in.): ductile iron Body to ASTM A536, EPDM pressure-responsive seat, electroless-nickel coated ductile iron disc, with stem offset from the disc centerline to provide complete 360-degree circumferential seating for temperatures up to +110 deg. C. (+230 deg. F.), for bubble-tight service to 2065 kPa (300 psi). Victaulic Vic-300 MasterSeal.
 - .1 Butterfly Valves 350 mm (14 in.) to 600 mm (24 in.): Ductile iron body to ASTM A536, EPDM disc mounted seal, PPS (polyphenylene sulphide) coated ductile iron disc, and stainless steel stem. (Stem shall be offset from the disc centerline to provide full 360- degree circumferential seating). Rated for temperatures up to + 110 deg. C. (+230 deg. F.), for bubbletight service to 2065 kPa (300 psi). Victaulic AGS Vic-300.
- 2.4.12. Check valves 65 mm (2-1/2 in.) to 300 mm (12 in.): ductile iron ASTM A536 EPDM coated disc spring loaded design for non-slam operation. Victaulic Series 716.
 - .1 Check valves 350 mm (14 in.) to 600 mm (24 in.): Ductile iron body to ASTM A395, dual stainless steel disc(s), with stainless steel spring and shaft, rated for temperatures up to +110 deg. C. (+230 deg. F.), for service to 1575 kPa (230 psi) Victaulic Series W715.
- 2.4.13. Strainers 50 mm (2 in.) to 600 mm (24 in.): ductile iron ASTM A536 with type 304 stainless steel screen. Victaulic Style 730/732 and W730/W732.
- 2.4.14. As an alternative on vertical in-line pumps, suction elbow may be suction diffusers. Victaulic 731-D.
- 2.4.15. As an alternative to Standard Details for pumps, piping may be manufactured vibration isolation pump drop assemblies 50 mm (2 in.) to 300 mm (12 in.). Includes flow control, vibration-isolation flexible couplings, access ports for gauges and thermowells, isolation and check valves, strainer or suction guide and an integral flanged pump connection. Victaulic Series 380, 381, 382 or 383.
- 2.4.16. All grooved Products, including couplings, fittings, valves and specialty items shall be Victaulic.
- 2.4.17. For other system components refer to Low Temperature and/or Pressure Water Article.

2.7. PLAIN END PIPE COUPLINGS AND FITTINGS

- 2.7.1. For systems 120 deg. C. (248 deg. F.) at 2068 kPa (300 psi).
- 2.7.2. Plain end couplings fittings may be used for hot water, chilled water, hot or chilled glycol, and condenser water systems.
- 2.7.3. Pipes 12 mm (1/2 in.) to 50 mm (2 in.) black steel ASTM A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless," Schedule 40.
- 2.7.4. Couplings and fittings shall be ASTM A536 "Standard Specification for Ductile Iron Castings" grade 65-45-12 ductile iron housing segments, ASTM D2000 "Standard Classification System for Rubber Products in Automotive Applications" pressure responsive elastomer gasket, and ASTM A449 "Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use" zinc-electroplated steel bolts and nuts.
- 2.7.5. Gaskets: EPDM conforming to ASTM D2000 "Standard Classification System for Rubber Products in Automotive Applications," temperature range -34 deg. C. to 120 deg. C. (-29 deg. F. to 248 deg. F.).

2.8. WELDING

- 2.8.1. Pipe welding shall be in accordance with:
 - .1 ANSI/ASME B31.1
 - .2 ANSI/ASME Boiler and Pressure Vessel Code, Section IX.
 - .3 TSSA
 - .4 Authorities Having Jurisdiction
 - .5 CSA B51 - Boiler, Pressure Vessel and Pressure Piping Code
- 2.8.2. Ensure complete penetration of deposited metal with base metal. Manufacturer shall provide filler metal suitable for use with base metal. Keep inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process employing a shielded metallic arc process (SMAW). The use of a gas metal arc welding process (GMAW/ MIG) for pipe welding is not permitted. Inside of pipe shall be free of excessive reinforcement. The use of backing plates is not acceptable. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during the welding operation.
- 2.8.3. In no cases shall Schedule 40 or standard weight pipe be welded with less than three passes including one stringer/ root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/ root, two filler and one lacer/ cap.
- 2.8.4. Each weld shall be uniform in width and size throughout its full length. In addition, the cover pass (final weld layer) shall be free of coarse ripples, grooves, overlaps, abrupt ridges and valleys/ under cut. The surface smoothness of the finished weld shall be suitable for the proper interpretation of non-destructive examination of the weld.
- 2.8.5. Each weld layer or pass shall be visually free of slag, inclusions, cracks, porosity and lack of fusion. Grinding to meet this criteria and elimination of defects and surface preparation of welds shall be done in a manner as not to gouge, groove or reduce the adjacent base material thickness below the minimum required.
- 2.8.6. All butt welds shall be full penetration with uniform crown, with reinforcement blending smoothly into the base material. Concavity on the root side of a single welded circumferential butt weld is permitted with the resulting thickness of the weld at least equal to the thickness of the thinner member of the sections being joined.

- 2.8.7. Socket welds shall have a gap of approximately 1.5 mm (1/16 in.) minimum to 3 mm (1/8 in.) maximum between the bottom of the socket and the end of the pipe prior to welding.
- 2.8.8. Visually inspect all welds for compliance with this section. Welds found to be lacking penetration, or containing excessive porosity or cracks must be removed and replaced with an original quality weld as specified herein.
- 2.9. PIPE COATINGS
- 2.9.1. For carbon steel piping: primer coated with an epoxy coating, 5 mil thickness or manufacturer's recommended thickness, whichever is more stringent.
- 2.9.2. For stainless steel piping: coated with an epoxy primer, 5 mil thickness or manufacturer's recommended thickness, whichever is more stringent, and an epoxy finish coat, 5 mil thickness or manufacturer's recommended thickness, whichever is more stringent.
- 2.10. GENERAL REQUIREMENTS FOR PIPE SYSTEMS
- 2.10.1. Where a branch at least two pipe sizes smaller connects into a main, welding fittings of Bonney Forge, full flow fittings or other approved manufacturer may be used.
- 2.10.2. For chilled, condenser and low temperature heating water, where a branch at least two pipe sizes smaller connects into a main, branch may be mitred and welded to main.
- 2.10.3. Use Y pattern strainers with screens of type 304 stainless steel or Monel with approximately 1 mm (1/32 in.) perforations for sizes 100 mm (4 in.) and smaller, and approximately 3 mm (1/8 in.) perforations for larger sizes. Provide a valved blow-off connection in all caps 65 mm (2-1/2 in.) and larger. Maximum pressure drop with clean screen shall not exceed 7 kPa (1 psi) with water velocity through inlet pipe of 1.5 m/s (5 ft./s). For 50 mm (2 in.) and larger pipe size all heads retaining the basket shall be bolted. For 38 mm (1-1/2 in.) and smaller pipe heads shall be gasketed with straight threads.
- 2.10.4. Solder end globe, angle and gate valves, sizes 50 mm (2 in.) and smaller, are acceptable if it can be shown that they are similar in design and construction to the valves specified.
- 2.10.5. Except where special features are required or unless otherwise approved, all globe, gate and check valves shall be of one manufacturer, with the manufacturer's name and the pressure rating clearly marked on the outside of the valve body.
- 2.10.6. Strainers shall be Colton Industries or Mueller.
- 2.10.7. Air vents shall be Bell and Gosset, Taco, Sarco, Watts, Zurn, or Maid-O-Mist.
- 2.10.8. Manufacture air separators in an ISO recognized facility. Factory test each unit per Hydraulic Institute standards at the factory of origin. Provide tangential type air separator with flanged or grooved inlet and outlet connections. Provide the vessel shell diameter as three times the nominal inlet/outlet pipe diameter. Provide inlet and outlet connections of the same size. Design, construct, and stamp the unit for the system design pressure class in accordance with ASME Boiler and Pressure Vessel Code. Supply the separator with automatic air vent, and connect the vent connection into the bottom of the compression tank for air control systems.

- 2.10.9. Manufacture air and dirt separators in an ISO recognized facility. Factory test each unit per Hydraulic Institute standards at the factory of origin. Provide air and dirt separator with flanged or grooved inlet and outlet connections. Provide the vessel shell diameter as three times the nominal inlet/outlet pipe diameter and provide the separator complete with coalescing media. Provide air and dirt separator that allows access for removal and cleaning of coalescing media. Provide bottom of air and dirt separator with dirt chamber and ball valve for dirt purge. Provide separator with inlet and outlet connections of the same size. Design, construct and stamp the separator for the system design pressure class in accordance with ASME Boiler and Pressure Vessel Code. Supply the separator with automatic air vent and connect the vent connection into the bottom of the compression tank for air control systems. Provide air and dirt separator from one of the following manufacturers: Spirotherm Spirovent, Xylem Bell & Gossett, Taco, or Armstrong.
- 2.11. BUFFER TANKS
- 2.11.1. Acceptable manufacturers for buffer tanks for hydronic heating and cooling systems: Niles Steel, Lochinvar, Amtrol, A.O. Smith, Wessels, or Taco.
- 2.11.2. Construct tanks in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code, and design and stamp tanks for 860 kPa (125 psi) operating pressure.
- 2.11.3. Construct tanks of carbon steel. Provide an internal baffle for 2-port tanks. Prime exterior surfaces and paint with red oxide paint.
- 2.11.4. Include with tank: screwed, flanged, or grooved system connections at the same elevation; temperature gauge port; pressure relief valve; drain valve connection; and air vent connection.
- 2.11.5. Provide tanks complete with ring base and lifting rings. Provide tanks that are self supporting.
- 2.11.6. Provide tank with capacity and dimensions as follows:
- .1 Chilled Water System BT-01: _____ L (_____ US gal) volume, _____ mm (_____ in.) tall, _____ mm (_____ in.) diameter.
 - .2 Heating Water System BT-02: _____ L (_____ US gal) volume, _____ mm (_____ in.) tall, _____ mm (_____ in.) diameter.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. For pipe 65 mm (2-1/2 in.) and larger, use flanges, and for smaller pipe, use unions at all valves and equipment.
- 3.1.2. Flare connections may be used on soft copper tubing where one end of the flare connection is an integral part of the equipment or valve.
- 3.1.3. Provide pipe coatings in accordance with the requirements of this section, where carbon steel piping or stainless steel piping is installed exterior to the building.
- 3.1.4. Provide automatic air vents at all high points on piping mains for hot and chilled water systems. Where venting a horizontal pipe, grade pipe up in direction of flow with vent at high point. Provide gate valve at the float inlet. Pipe outlets to drain using copper pipe. Drain pipe shall be run such that its route is visible.
- 3.1.5. Provide manual air vents on all hot water heating units where air may be trapped. Use screw-driver operated vents of chrome plated brass. Vents shall be accessible without removing cover of heating unit.
- 3.1.6. Provide air separators and air and dirt separators where shown on the Drawings.

- 3.1.7. Arrange all runs of piping to prevent interference and to achieve a satisfactory and professional installation of neat appearance. Run all piping parallel to walls. All valves, controls, equipment, expansion compensators, flexible connections and, as far as possible, all piping shall be easily accessible for inspection, maintenance and operation.
- 3.1.8. Pitch all lines 25 mm in 12 m (1 in. in 40 ft.-0 in.) unless shown otherwise.
- 3.1.9. Install drain valves at all low points for draining and locate where easily accessible. In order to achieve this, install remote from system where necessary, clearly marked. Typical marking similar to the following:
 - .1 Heating system
 - .2 Danger, authorized personnel only
- 3.1.10. Carefully ream threaded joints and join with compound on the male thread only. Re-tighten flanged connections after the installation has been brought up to its service. Following testing, apply insulation. Take care not to overstress the material during construction.
- 3.1.11. Pipe welding operations shall be performed by welders Provincial Certification for the class of piping to be welded. Ensure the internal opening of pipes and fittings are not restricted by superfluous material.
- 3.1.12. When welding or cutting with a torch, take precautions to prevent fire by maintaining fully charged 4.5 kg (10 lbs.) carbon dioxide extinguisher immediately adjacent to the operation. Protect wooden structure with fire retardant blankets.
- 3.1.13. Arrange piping to permit ease of equipment removal. Provide flanges or unions on all pipe connections to each piece of equipment.
- 3.1.14. Connect all multi-row water coils in counter flow.
- 3.1.15. Drains from packaged air handling unit drain pans shall be of same size as connection on unit. Provide traps on all drains and deep seal traps on both sides of the fan and coil sections.
- 3.1.16. Connect bases of all pumps with packed glands to drain with 12 mm (1/2 in.) OD copper tubing.
- 3.1.17. Provide on the discharge line of each spray pump, a 12 mm (1/2 in.) valved bleed-off. Connect to discharge line above sump water level and run to drain.
- 3.1.18. Provide strainers upstream of each pump suction, steam control valve and steam trap not preceded by a control valve, and where shown.
- 3.1.19. Provide butterfly valves where shown; these are permitted in lieu of gate valves in sizes 65 mm (2-1/2 in.) and larger.
- 3.1.20. Install all valves in Equipment Rooms in accessible locations from the floor. Where valves are not accessible from the floor, equip with chain operators at the discretion of the Engineer's Representative.
- 3.1.21. Provide gate, globe and check valves in all piping systems as shown and as required for satisfactory operation and control of equipment. Provide shut-off valves wherever piping is connected to all equipment. Provide one flow balancing valve and one shut-off valve on water coils.
- 3.1.22. Provide for the expansion and contraction of all pipes. Install with sufficient flexibility to prevent end-thrust and movements caused by thermal expansion or Contraction causing detrimental distortion or damage of connection equipment. Provide offsets between mains and equipment of sufficient length to safely absorb the expansion of the main.
- 3.1.23. Install all control devices, valves and any other appurtenances as directed by the controls and/or BAS trades.
- 3.1.24. Make connections between copper and steel with brass or bronze fittings.

- 3.1.25. Ball valves may be used in low temperature and/or pressure systems only in lieu of gate valves in 50 mm (2 in.) and smaller. Provide union downstream of ball valves for servicing if ball valve is not a three piece design.
- 3.1.26. For grooved piping, ensure ends are clean and free from indentations, projections, and roll marks in the area from the pipe end to the groove for proper gasket sealing. Ensure all couplings meet the manufacturer's standards for visual inspection. Verify the gasket style and elastomeric material (grade) as suitable for the intended service as specified. Install in accordance with manufacturer's latest written recommendations. Have a manufacturer's factory trained representative periodically visit the site and review the installation for best practices. Correct any identified deficiencies. For Grooved Product that has been examined and has not met the visual inspection criteria for proper installation, correct and have the manufacturer re-examine prior to the completion of the Work. Install flow balancing valves in sections of straight pipe as recommended by the manufacturer, but in no case with less than 10 pipe diameters upstream of the valve.
- 3.1.27. Install flow balancing valves in the following locations:
- .1 At each heating, chilled or condenser water riser, or main floor branch
 - .2 Each heating water and cooling water coils including unit heaters, fan coils and force flow heaters
 - .3 Each heat exchanger
 - .4 Each wall fin, radiant ceiling or similar heating device
 - .5 Each heat pump
 - .6 Each differential pressure bypass control valve line
 - .7 Each main building or secondary heating or cooling circuit
 - .8 And where shown
- 3.1.28. Provide bird screen on all vents terminating horizontally, with a gooseneck or other configurations where a vent stack cover is not provided.
- 3.1.29. Buffer tanks:
- .1 Place tanks on 100 mm high housekeeping pads.
 - .2 Provide drain valve, automatic air eliminator, and pressure relief valve for buffer tanks and pipe to nearest floor drain.
 - .3 Provide a manual isolation valve on each buffer tank system connection.

END OF SECTION

23 21 23.00 Centrifugal Pumps

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.2. GENERAL

2.2.1. Single or double suction pumps, as shown, from:

- .1 Armstrong
- .2 Xylem Bell & Gossett
- .3 Taco
- .4 Grundfos-Paco
- .5 Patterson Pump Company
- .6 Wilo

2.2.2. Pumps shown as operating in parallel must be selected for stable performance under single pump operation. Submit Shop Drawings showing both single and parallel pump operation.

2.2.3. Pump volute shall be sized for a maximum of 17 fps velocity. When a pump cannot meet this requirement the manufacturer shall clearly indicate this on the Shop Drawing and include a written explanation as to why the particular pump has been selected.

2.2.4. Impeller shall be enclosed type. Complete impeller and shaft assembly shall be statically and dynamically balanced.

2.2.5. For fixed speed pumps impeller shall not exceed 85 percent of casing cut water point. For variable speed pumps the duty point shall be selected similar to a fixed speed pump and the impeller shall be maximized to operate 5% greater than the rated motor horsepower at pump run out.

2.2.6. Pump inlet and outlet shall be flanged for 860 kPa (125 psi) ANSI flanges or for 1720 kPa (250 psi) ANSI flanges to meet the system requirements. Inlet and outlet flanges shall be equal in size.

2.2.7. Motor shall be in conformance with Section 20 05 13.00 - ELECTRIC MOTORS.

2.2.8. Select motors to be non-overloading over the entire pump curve.

2.2.9. Provide pumps in accordance with the Pump Schedule.

2.2.10. Where Vertical In-Line pumps are scheduled or specified as the basis of design, base mounted pumps shall not be permitted as a substitute.

2.3. BASE MOUNTED PUMPS

- 2.3.1. Each base mounted pump shall have a heavy cast iron or steel base for common support of the pump and direct connected motor.
- .1 Pump and motor shall be connected through a flexible coupling supplied with the pump. For variable speed applications provide a suitable coupling.
 - .2 A coupling guard shall be provided to OSHA standards.
 - .3 Pump casing shall be cast iron, impeller shall be bronze, shaft shall be stainless steel or steel with bronze sleeves.
 - .4 Bearings shall be ball type, mounted inboard and outboard in supporting mandrel.
 - .5 Bearings shall be grease or oil lubricated type. Permanently lubricated bearings are not acceptable.
- 2.3.2. For base mounted pumps a stuffing box with packing shall be provided for condenser water pumps.
- 2.3.3. Casing shall be fitted with properly anchored impeller wear rings for all base mounted pumps.

2.4. VERTICAL IN-LINE PUMPS

- 2.4.1. Pumps shall be vertical P base motor driven units with split type rigid spacer coupling for pumps 7.5 kW (10 hp) and over to be easily removed on site to reveal a space between the pump and motor sufficient to allow servicing of seal without disturbing pump or motor.
- .1 Casing shall be cast iron, impeller shall be bronze and shaft shall be stainless steel.
 - .2 Mechanical seal shall be outside balanced.
 - .3 For double volute pumps less than 345 kPa (50 psi) operating pressure, inside unbalanced mechanical seals are acceptable. For operating pressures 345 kPa (50 psi) and higher, a balanced mechanical seal shall be provided.
- 2.4.2. Seal flushing connection complete with filter and sight flow indicator to suit system working conditions shall be provided on all pumps 7.5 kW (10 hp) and over. Filter shall be sized to suit the flow rate required for the seal and shall be oversized by three times for glycol systems.
- .1 As an alternative to the above provide a cyclone sediment separator and sight flow indicator where differential pressures exceed 207 kPa (30 psi).
- 2.4.3. Internal mechanical seal shall be John Crane Silicon Carbide or equal.
- 2.4.4. External mechanical seal shall be stainless steel multi-spring outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat.
- .1 Provide a 316 stainless steel gland plate.
 - .2 Provide a factory installed flushline with manual vent.
- 2.4.5. For heating systems with operating temperatures greater than 82.2 deg. C. (180 deg. F.) and for condenser water systems use Silicon Carbide seals.
- 2.4.6. Provide strainer guide vanes on vertical suction piping section of all vertical in-line pumps, where specifically shown. Refer to Section 23 21 13.23 - PIPES, VALVES AND FITTINGS for detailed Specification.

3. Execution

3.1. INSTALLATION

- 3.1.1. Grout base-mounted pumps to vibration isolation base after shimming and aligning in accordance with manufacturer's written instructions. Alignment shall be provided by a certified millwright once at start-up and once at operating temperature. Grout void under steel or cast iron base full of concrete. Base shall be large enough to support base elbow at pump suction for single suction pumps and both suction and discharge elbow on double suction pumps.
- 3.1.2. Increases and reducers on pump suction and discharge shall be eccentric fittings and shall be of a gradual increase or reduction to prevent unnecessary turbulence or noise.
- 3.1.3. Provide vibration isolation and flexible connections for all pumps in accordance with Section 20 05 48.00 - VIBRATION AND NOISE CONTROL.
- 3.1.4. Filters shall be changed by this Division after the system is flushed and on a regular basis until handed over to the Owner or their representatives.

END OF SECTION

23 22 53.00 Pressure Relief Valves

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. All pressure relief valves shall be code rated for the service and shall be approved under Canadian Interprovincial Boiler Inspection Regulations.

2.1.2. Pressure relief valves shall be Spirax Sarco or approved equal.

3. Execution

3.1. INSTALLATION

3.1.1. Hot water pressure relief valves shall operate at 207 kPa (30 psi) unless shown otherwise. Where higher pressure relief settings are required, relief valve shall operate at 70 kPa (10 psi) less than the maximum rated pressure of the lowest rated system component (tank, boiler, heat exchanger, etc.) or 1034 kPa (150 psi) whichever is less.

END OF SECTION

23 23 01.00 Refrigerant Piping

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.1.2. Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. SUBMITTALS
 - 1.2.1. Submit Product data sheets for all Products required, except for pipe and fittings.
 - 1.2.2. Submit a schematic piping diagram for each refrigerant piping system indicating pipe sizes, slopes, valves, traps, and piping specialties sealed by a Professional Engineer in the Province of the installation.
 - 1.2.3. Submit confirmation of registration of the Project with the Authority Having Jurisdiction.
 - 1.3. REGULATORY COMPLIANCE AND QUALITY ASSURANCE
 - 1.3.1. The installing Contractor shall be certified and shall register all Projects in accordance with the requirements of the Authority Having Jurisdiction.
 - 1.3.3. All components of a refrigeration piping system shall have a Canadian Registration Number or CSA certification acceptable to Authority Having Jurisdiction.
 - 1.3.4. All systems shall display appropriate Ozone Depletion Prevention (ODP) tags prior to commissioning. Manufacturer shall not commission any system not displaying proper ODP tags.
 - 1.4. SPECIAL CONSIDERATIONS FOR VARIABLE REFRIGERANT FLOW (VRF) PIPING SYSTEMS
 - 1.4.1. VRF refrigeration piping systems shall be installed as per the balance of this Specification with the following considerations and/or exceptions:
 - 1.4.2. Refrigerant Contractors shall be certified by the VRF Equipment Supplier. Proof of training certification shall be made available upon request.
 - 1.4.3. There shall be minimal use of refrigeration specialties (filter driers, accumulators, receivers, check valves, etc.) in the VRF pipe system. Install in accordance with VRF manufacturer's recommendations.
 - 1.4.4. Pressure relief valves shall be 4482 kPa (650 PSI) rated and installed in pairs (two valves per circuit).
 - 1.4.5. Y style piping joints and headers shall be provided by the manufacturer to ensure proper refrigerant balance and flow for optimum system capacity and performance.
 - 1.4.6. T style joints, field fabricated joints, or Y joints that are not provided by the manufacturer shall not be permitted.
 - 1.4.7. Approved flaring block, and approved torque wrenches, both available from VRF manufacturer, shall be used for all flare connections.

- 1.4.8. Pipe clamps shall fasten around the piping insulation. Pipe clamps that compress the copper directly shall be installed a minimum of 900 mm (36 in) away from joints, and shall be loosely tightened to allow for copper expansion.
- 1.4.9. Provide VRF manufacturer with actual pipe lengths installed for calculation of refrigerant charge. Supply and charge VRF system with required quantity of refrigerant prior to VRF manufacturer commissioning. Refrigerant charging shall be done in the liquid state.
- 1.5. WARRANTY
- 1.5.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 2. Products
- 2.1. PIPE, FITTINGS AND JOINTS
- 2.1.1. Provide hard drawn, air conditioning / refrigerant grade ASTM B280 “Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service” copper piping for runs longer than 3 m (10 ft.); for shorter runs air conditioning / refrigerant grade ASTM B280 soft annealed copper piping is permissible provided the requirements of Part 3 are met..
 - .1 Braze all joints except as noted.
 - .2 Joints 22 mm (7/8 in) and smaller may be flared.
 - .3 Fittings shall be cast copper alloy for flared copper tube, or wrought copper and bronze solder-joint pressure fittings.
 - .4 Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings.
 - .5 Cast sweat-type joints and fittings shall not be permitted for brazed joints.
 - .6 Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of equipment.
- 2.2. BRAZING FILLER METAL
- 2.2.1. Filler metal shall be type BAg-5 with AWS Type 3 flux except as noted.
- 2.2.2. Copper to copper joint filler metal shall be BCuP-5 or BCuP-6.
- 2.2.3. Brazing rods for all joints shall be 15 % Lucas Milhaupt “sil-Fos”.
- 2.3. VALVES
- 2.3.1. Valves shall be designed, manufactured, and tested specifically for refrigerant service. Valve bodies shall be of brass, bronze, steel, or ductile iron construction. Valves 25 mm (1 in) and smaller shall have brazed or socket welded connections. Valves larger than 25 mm (1 in) shall have butt welded end connections. Threaded end connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections. Valve stems exposed to the atmosphere shall be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow shall be legibly and permanently indicated on the valve body. Purge, charge and receiver valves shall be of manufacturer’s standard configuration.
- 2.3.2. Refrigerant access valves and hose connections shall be in accordance with AHRI 720.

- 2.3.3. Isolation valves shall be installed where shown on the schematics. Isolation valves shall be bi-flow self-seating with operating pressures up to 4482 kPa (650 PSI). Valves shall be complete with brass Schrader connections located on the valve body only.
- 2.3.4. Check Valves shall be Mueller Industries Inc. "Checkmaster" straight through type for valves 6.4 mm to 16 mm (1/4 in to 5/8 in) diameter, globe type for valves 22 mm (7/8 in) diameter and larger, each complete with extended tubing for brazing connections, and as follows:
- .1 Straight through type check valves are to be complete with a machined brass gasketed body, phosphor bronze spring, and neoprene seat.
 - .2 Globe type check valves are to be complete with a cast bronze body, forged brass cap, phosphor bronze spring, PTFE seat disc, and neoprene O-ring seal.
- 2.3.5. Liquid Solenoid Valves
- .1 Ball type valves as specified above, each in accordance with AHRI 760 and be suitable for continuous duty with applied voltages 15 % under and 5 % over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions, direct-acting or pilot-operating type, moisture-proof, ULC approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have an operating pressure differential suitable for the refrigerant used.
- 2.3.6. Expansion Valves
- .1 Valve shall be the diaphragm and spring-loaded type with external equalizers, and bulb and capillary tubing. Valve shall be equipped with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 1 Deg. C. (2 Deg. F.) of saturated suction temperature at evaporator conditions. Pilot-operated valves shall have a characterized plug to provide required modulating control.
 - .2 Electronic expansion valves shall be brass body, needle valve with floating needle and machined seat, stepper motor drive.
- 2.3.7. Safety Relief Valves
- .1 Suction lines shall be rated at 2413 kPa (350 PSI) and liquid at 4482 kPa (650 PSI) or liquid and discharge lines at 4482 kPa (650 PSI) respectively.
 - .2 Purpose built Y-fitting shall be Superior Products model 3155W.
- 2.3.8. Evaporator Pressure Regulators, Direct-Acting
- .1 Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 1 Deg. C. (2 Deg. F.) change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.
- 2.4. PIPING ACCESSORIES
- 2.4.1. Filter Driers
- .1 Sizes 15 mm (5/8 in) and larger shall be the full flow, replaceable core type. Sizes 15 mm (1/2 in) and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of

the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 10.3 MPa (1500 PSI).

2.4.2. Discharge Line Oil Separator

- .1 Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.

2.4.3. Accumulator

- .1 Accumulators shall be provided in the suction line to protect the compressor from liquid refrigerant damage. Accumulator shall be cUL listed under the required operating pressures and must be installed as close to the compressor as possible.

2.4.4. Refrigerant Moisture and Liquid Indicators

- .1 Indicators shall be single or double port, ULC listed. Body shall be copper or brass with flared or soldered ends. Sight glass shall have color coded paper moisture indicator with removable element cartridge and plastic cap. Maximum working pressure shall be 3447 kPa (500 PSIG). Maximum working temperature shall be 93.3 Deg. C. (200 Deg. F.).

2.4.5. Pressure and Vacuum Gauges

- .1 Gauges shall conform to ASME B40.100 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 85 mm (3-1/2 in) in diameter with a range from 0 kPa (0 PSIG) to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.4.6. Insulation

- .1 Liquid, suction and hot gas lines shall be individually insulated in accordance with Section 20 07 00.00 – INSULATION.

3. Execution

3.1. GENERAL

- 3.1.1. Consider the piping shown on the Drawings as diagrammatic, indicating the general runs and connections only, and parts may not be shown in the true position. Be responsible for the proper erection of the systems of piping in every respect suitable for the work intended.
- 3.1.2. Install all piping in a professional manner and in accordance with the best practices of the trade. Piping shall be pitched 13 mm (1/2 in) for every 3000 mm (10 ft) of length in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and as shown.
- 3.1.3. Pipe supports shall be a maximum of 1800 mm (6 ft.) apart. Pipe clamps shall fasten around the piping.
- 3.1.4. Piping supports and guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

- 3.1.5. Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.
- 3.1.6. Install in accordance with CSA B52 and ASME B31.5 Mechanical Refrigeration Code.
- 3.1.7. Safety pressure relief valves shall be installed in the piping as per CSA B52. All pressure relief valves and brazed joints shall be suitably sized.
- 3.1.8. Install two pressure relief valves per refrigeration circuit using a purpose built "Y" fitting complete with integral ball valves.
- 3.1.9. Install on the liquid and suction line or liquid and discharge line as per Drawing details. Pressure relief valves shall be individually isolated to allow for maintenance and replacement.
- 3.1.10. Nitrogen purging / sweeping shall be used when brazing and welding to minimize oxidization.
- 3.1.11. Isolation valves shall be installed where shown on the schematics or as required.
- 3.1.12. Prevent the release of refrigerants into the atmosphere during installation and testing.
- 3.1.13. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Pipe or tubing shall be cut square reamed to remove burrs, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.
- 3.1.14. Install pipe, valves, and fittings to facilitate easy maintenance. Do not locate valves, couplings, or flanged/union connections directly above electrical panels, motor starters or MCCs.
- 3.1.15. Where soft annealed copper piping is permissible above, install it straight and free of dips that may trap refrigerant.
- 3.1.16. A liquid line filter dryer shall be installed in each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed.
- 3.1.17. A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers and where indicated. Site glasses shall be full line size.
- 3.1.18. Arrange for review and acceptance of all refrigerant pipe joints by the Authority Having Jurisdiction prior to concealing the joints.

END OF SECTION

23 25 13.00 Heating System Chemical Treatment

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Shop Drawings: Submit Shop Drawings of all components of the system in accordance with SECTION 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS. Include all wiring diagrams.

1.2.2. Manufacturer's Data: Submit details of all testing equipment to be provided.

1.3. QUALITY ASSURANCE

1.3.1. Qualifications of Manufacturers: Work under this section shall be limited to the following companies:

- .1 Solenis
- .2 GE Water and Process Technologies
- .3 Anco Chemicals Water Treatment Inc.
- .4 Norkem Inc.
- .5 Klenzoid

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.2. CLOSED RECIRCULATING LOOP FOR HEATING SYSTEM

2.2.1. For each heating system provide an adequately sized pot feeder for the entire system but not less than a 7.6 L (2 gallon) pot feeder. Pot feeder shall have a maximum working pressure of 300 psi at 200 deg F. Tank shell shall be 10 gauge steel, tank heads shall be 9 gauge steel, and cap shall be cast iron with Buna N seal ring, equal to Solenis PN 9233-03-2 or Neptune DBF-2HP. Pot feeder assembly shall be complete with valved inlet and outlet, screen, drain and pot feeder.

2.2.2. For each heating system provide an adequately sized pot feeder for the entire system but not less than a 19 L (5 gallon) pot feeder. Pot feeder shall have a maximum working pressure of 300 psi at 200 deg F. Tank shell and heads shall be 11 gauge steel, and cap shall be cast iron with Buna N seal ring, equal to Solenis PN 9233-04-0, or Neptune DBF-5HP. Pot feeder assembly shall be complete with valved inlet and outlet, screen, drain and pot feeder.

- 2.2.3. Provide two (2) corrosion test coupons, one copper equal to Drew PN 7721-01-3 and one steel equal to Solenis PN-7722-01-1. Corrosion coupons to be installed in 19 mm (3/4 in.) tee fittings on the upstream side of the pot feeder.
- 2.2.4. Corrosion and scale inhibitor for closed loop heating systems shall be equal to GE W&P Technologies CORRSIELD MD4102 or Solenis CSW 311.
- 2.2.5. Provide an adequate quantity of chemical treatment for 6 months of operation after Substantial Completion of the Contract.
- 2.2.6. Provide bypass filter as specified in Section 23 25 14.00 - PIPE SYSTEM FILTERS.

3. Execution

3.1. INSTALLATION

- 3.1.1. Pot feeder is to be installed in parallel with filter on supply and return line headers. Headers shall be in an accessible location, less than 1.5 m (5 ft.) above the floor.
- 3.1.2. The Water Treatment Supplier shall provide a service program for a period of 1 year from Substantial Completion of the Contract. Service visits shall be conducted on regular frequency suitable to meet system stability requirements. A report containing findings and recommendations shall be submitted to the Owner following each visit.
- 3.1.3. Provide two days service (7-1/2 hours per day) of manufacturer's representative to add chemicals to the systems until properly protected, adjust the equipment and the blow down rates. Representative shall also, during this time, instruct the Owner's representative in the correct use of the treatment, show the Owner the test results for the systems, how to test the systems, and how often.

END OF SECTION

23 25 14.00 Pipe System Filters

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. For systems under 600 GPM, provide pipe system filter housings capable of receiving a single double open end (DOE) filter cartridge. Construct head of cast iron; construct shell of Type 304 or Type 316L stainless steel.

2.1.2. For systems over 600 GPM, provide pipe system filter housings capable of receiving multiple double open end (DOE) filter cartridges. Construct shell and heads of Type 316L stainless steel.

2.1.3. Provide shell and heads suitable for 1035 kPa (150 psi) working pressure and provide filter media suitable for 149 deg. C. (300 deg. F.) service temperature.

2.1.4. Provide bleached cotton filter media for selective removal of particles from 1 to 100 microns. Provide non-rupturing media and mount so that no by-pass of media can occur.

2.1.5. Size filters for 3 % of total system flow and apply within the mid-capacity of the filter operating flow rate.

3. Execution

3.1. INSTALLATION

3.1.1. Install pipe system filters in the following systems:

- .1 Perimeter heating systems
- .2 Constant temperature heating system
- .3 Chilled water system

3.1.2. Install pipe system filters across the pumps with valved inlet and outlet. Provide flow balancing outlet valve. Refer to Section 23 21 13.23 - PIPES, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide flanges or unions for servicing. Provide valved drain on unit casing.

END OF SECTION

23 25 16.00 Chilled & Condenser Water Treatments

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Shop Drawings: Submit Shop Drawings of all components of the system in accordance with SECTION 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS. Include all wiring diagrams.

1.2.2. Manufacturer's Data: Submit details of all testing equipment to be provided.

1.3. QUALITY ASSURANCE

1.3.1. Qualifications of Manufacturers: Work under this section shall be limited to the following companies:

- .1 Solenis
- .2 GE Water and Process Technologies
- .3 Chem-Aqua.
- .4 Norkem Inc.
- .5 Klenzoid

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.2. OPEN RECIRCULATING SYSTEM (CONDENSER WATER)

2.2.1. Pre-piped, pre-wired non-acid chemical feed system complete with pumps on common mounting frame with 6 mm (1/4 in.) mild steel base plate. Provide interlock to prevent chemical make-up when condenser water pumps are off. System shall be suitable for cooling tower system having maximum circulating water rate as shown on the Cooling Tower Schedule.

2.2.2. Feed pump shall be capable of delivering 0.007 L/s (6.6 USGPH) against 690 kPa (100 psi) complete with built-in relief valve. Feed pumps shall be suitable to draw directly from the chemical supply containers.

2.2.3. Provide pre-wired baked enamel 1.5189 mm thick (0.0598 in. - 16 ga) steel control panel for all controls, starters, and similar components in colour selected by Engineer's Representative requirements. Each item shall be provided with lamacoid label.

2.2.4. Meter on make-up water system to cooling towers shall operate inhibitor chemical feed pumps through automatic reset timers. Timers shall be adjustable from 1 to 30 minutes.

- 2.2.5. Manual condenser water bleed off to drain shall be 12 mm (1/2 in.) Hancock Model 4585 flow control valve or other approved manufacturer.
- 2.2.6. Provide and install 4 coupon PVC corrosion test rack, complete with flow meter. Corrosion test rack shall be equal to GE W&P Technologies model 2042205, 1" NPT w/ 4 coupon holders, 8 GPM valve, 4 transparent viewing sections, two mild steel coupons and two copper coupons. Also provide 2041977 Replacement Coupon Holder, 1" Black Iron w/ 6" Teflon™ Stem and Teflon nut & Screw.
- 2.2.7. Automatic blow-down shall be by a conductivity controller that controls the quantity of dissolved solids by opening the normally closed control valve. Valve may be either electric or pneumatic operated. If pneumatic is used, provide air from the nearest control air line.
- 2.2.8. Provide 50 mm (2 in.) water meter in make-up water line to cooling tower. Provide water meter with auxiliary contact for operating automatic chemical feed controls.
- 2.2.9. Injector shall be PVC construction and complete with shut off valve and double check valve. Chemicals are fed neat from their shipping containers and shall be injected into condenser water line down stream of the condensers. Chemicals shall be equal to:
- .1 Scale and Corrosion Inhibitor - Solenis Performax Millennium
 - .2 Alternating Biocide - Solenis Biosperse 250 and Biocide T
- 2.2.10. All piping, valves and fittings shall be PVC.
- 2.2.11. Provide sufficient quantity of algaecides and biocides for algae and slime control for six months following Substantial Completion of the Contract.
- 2.3. CLOSED RECIRCULATING SYSTEM (CHILLED WATER)
- 2.3.1. For each chilled water system provide an adequately sized pot feeder to inject nitrate borate solutions into the entire system but not less than a 7.6 L (2 gallon) pot feeder. Pot feeder shall have a maximum working pressure of 300 psi at 200 deg F. Tank shell shall be 10 gauge steel, tank heads shall be 9 gauge steel, and cap shall be cast iron with Buna N seal ring, equal to Solenis PN 9233-03-2 or GE W&P Technologies DBF-2. Pot feeder assembly shall be complete with valved inlet and outlet, screen, drain and pot feeder.
- 2.3.2. For each chilled water system provide an adequately sized pot feeder for the entire system but not less than a 19 L (5 gallon) pot feeder. Pot feeder shall have a maximum working pressure of 300 psi at 200 deg F. Tank shell and heads shall be 11 gauge steel, and cap shall be cast iron with Buna N seal ring, equal to Solenis PN 9233-04-0, or GE W&P Technologies DBF-5. Pot feeder assembly shall be complete with valved inlet and outlet, screen, drain and pot feeder.
- 2.3.3. Provide two (2) corrosion test coupons, one copper equal to Solenis PN 7721-01-3 and one steel equal to Solenis PN-7722-01-1. Corrosion coupons to be installed in 19 mm (3/4 in.) tee fittings on the upstream side of the pot feeder.
- 2.3.4. Spray coils on each system shall be provided with a chemical treatment system controlled from a make-up water meter to supply a sequestering agent to the spray water. Bleed-off shall be controlled from a conductivity controller. Provide a biocide/algaecide for control of slime in the tank.
- 2.3.5. Corrosion and scale inhibitor for closed loop heating systems shall be equal to GE W&P Technologies CORRSHIELD MD4102 or Solenis CSW 311.
- 2.3.6. Provide an adequate quantity of each type of chemical for complete oxygen removal, scale protection or other type of protection sufficient to treat the entire system or systems for six (6) months after Substantial Completion of the Contract.

- 2.3.7. Provide testing equipment as per SECTION 23 25 26.00 - CLEANING AND FILLING for all types of chemicals used in the systems. Equipment shall be mounted in a baked enamel steel storage cabinet with hinged door. Colour of cabinet shall be to the Engineer's Representative's requirements.
- 2.3.8. Provide bypass filter as specified in SECTION 23 25 14.00 - PIPE SYSTEM FILTERS.
- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Pot feeder is to be installed in parallel with filter on supply and return line headers. Headers shall be in an accessible location, less than 1.5m (5 ft) above the floor.
 - 3.1.2. The Water Treatment Supplier shall provide a service program for a period of 1 year from Substantial Completion of the Contract. Service visits shall be conducted on regular frequency suitable to meet system stability requirements. A report containing findings and recommendations shall be submitted to the Owner following each visit.
 - 3.1.3. Install system in accordance with reviewed Shop Drawings and manufacturer's installation instructions.
 - 3.1.4. Wall mount control panel, starters, and similar components where shown, unless otherwise directed. Controls shall be flush mounted. Provide manual-off-automatic switches for chemical feed pumps together with running and trip lights. Provide interlock with condenser water pumps to prevent chemical injection when condenser water pumps are off.
 - 3.1.5. Furnish isolating gate valve upstream of the bleed off valve.
 - 3.1.6. Furnish isolating gate valve upstream of the control valve.
 - 3.1.7. Furnish control valve, size of which shall be equal to the blow-down pipe size.
 - 3.1.8. Install isolating valves and valved by-pass around water meter. Provide interconnecting wiring between meter and chemical feed control system.
 - 3.1.9. Provide manufacturer's representative to add chemicals to the systems until properly protected, adjust the equipment and the cooling tower bleed-off. Representative shall also instruct the Owner's representative in the correct use of the treatment. Upon completion submit a letter stating that all systems have been correctly set-up, are operating as required for adequate protection, and the Owner has received adequate instruction for the ongoing maintenance of the systems.
 - 3.1.10. Provide all interconnecting wiring and piping to complete the system. All electrical connections as required are the responsibility of the Mechanical Contractor.

END OF SECTION

23 25 26.00 Cleaning and Filling

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Shop Drawings: Submit Shop Drawings of all chemicals used in the system in accordance with SECTION 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Water piping cleaning solution for closed loop systems shall be equal to GE W&P Technologies FERROQUEST FQ7103 or Solenis CSW 600. Refer to manufacturer's written instructions for chemical concentrations.

2.1.2. Provide inhibited ethylene glycol system solution that is 50% by volume of factory, pre-mixed solution. Acceptable Products: Dow Chemical Co. "Dowtherm SR-1", Interstate Chemical Co. "Intercool NFE", Chemfax Chem-Cool, or Recochem Inc. "Recotherm IG".

2.1.3. Provide inhibited propylene glycol system solution that is 50% by volume of factory, pre-mixed solution. Acceptable Products: Chemfax Chem-Frost propylene glycol.

2.1.4. Provide alcohol Anti-freeze solution that is 40% by volume of Anchem Sales "Ancool-100."

2.1.5. Glycol make-up packages shall be provided for glycol water make-up. Each glycol make up package shall be equal to Solenis Chemical E5800; PN 9243-01-5, Expanflex model GMP-2-50, GE W&P Technologies AGS-2045, or Armstrong GLA-STD-LP-1 for 1.8 gpm make-up at 50 psig with a 120 V (1/3 hp) motor and 50 gallon polyethylene storage tank complete with hinged cover. Unit shall be complete with cut-off and (audible and visual) alarm in case of high pressure or low solution level. The pumping assembly shall be mounted in a sturdy steel frame, complete with legs to keep it off the floor. The package shall include a motor, a pump, a magnetic starter, a pressure tank, a priming valve, a PRV, a shut-off valve and a pressure gauge

3. Execution

3.1. INSTALLATION

3.1.1. All systems shall have been hydrostatically tested prior to cleaning.

3.1.2. Thoroughly flush all systems with raw water to remove loose mill scale and debris. Remove and clean all strainers and flush low points before chemical cleaner is added.

- 3.1.3. Disconnect all coils and by-pass flow.
- 3.1.4. A temporary pump shall be installed in the system and shall be capable of pumping adequate discharge at adequate head.
- 3.1.5. A temporary heater shall be installed in the system and shall be capable of maintaining the circulating water temperature as required for chemical treatment.
- 3.1.6. Systems shall be filled with city water and approved chemical cleaner introduced by a small temporary chemical injector pump at the temporary circulating pump section. Cleaner shall be introduced to maintain concentrations as per the manufacturer's recommendations.
- 3.1.7. All systems shall be cleaned in accordance with manufacturer's written instructions and under the supervision of the Chemical Supplier's representative. Minimum cleaning procedures shall be to fill all water piping cleaning solution, circulate at 1.5 times specified system flow rate and maintain at highest possible temperature for 72 hours. During this period heavy blowdown of all low points shall be carried out every 6 hours. Strainers shall be cleaned as necessary to permit maximum flow possible and, in any event, at least every 6 hours. Drain the solution, all strainers, and flush entire system with clean water for a minimum of 24 hours. Repeat fill and flush procedure as often as required, adding inhibitor with each fill, to achieve acceptable contaminant levels. Systems shall then be refilled, ready for use. Temperature of system for cleaning shall be to suit Chemical Supplier's requirements.
- 3.1.8. Take samples of system from a series of representative drains as directed by the Engineer's Representative. If system is still dirty, repeat cleaning procedure specified above until acceptable. Acceptable samples shall indicate that alkalinity and pH have returned to potable water levels. Copies of all test reports shall be submitted by the Water Treatment Supplier to the Engineer's Representative for verification prior to final filling.
- 3.1.9. Add fluid and chemical treatment immediately after cleaning has been completed and accepted. Acceptable control parameters shall be as follows:
 - .1 Nitrite: 1000 - 1500 ppm
 - .2 pH: 8.5 – 10 or as required by equipment manufacturer
 - .3 Iron: Less than 2.0 ppm
 - .4 Copper: Less than 0.3 ppm
 - .5 Molybdate: 100 - 150 ppm
 - .6 Hardness (CACO3): Less than 50 ppm or as required by equipment manufacturer (soften water as required)
- 3.1.10. For glycol systems install glycol make-up system as per manufacturer's written instructions and in accordance with Section 23 77 13.00 - EXPANSION TANKS. Fill system with specified glycol product to achieve the required glycol concentration. Glycol systems shall be provided with a Freezing Point Glycol Test Kit equal to Solenis PN 7729-01-7.
- 3.1.11. For ground source closed loop heat pump systems after cleaning and draining, fill the system with alcohol or propylene glycol anti-freeze solution as specified or shown in equipment schedules.
- 3.1.12. For tenant Work the Base Building Contractor shall drain and fill the base building system. Arrange and pay for this Work.
- 3.1.13. The Mechanical Contractor shall supply the Engineer's Representative with certified documentation from the Water Treatment Supplier that the systems have been properly equipped, chemically cleaned and that they are maintaining sufficient levels of scale/corrosion inhibitor. The Contractor shall request such documentation from the Water Treatment Supplier within one week of presentation to the Engineer's Representative.
- 3.1.14. A label or tag identifying any chemical additives, their concentration, and their maintenance requirements shall be permanently and prominently displayed on the heat source.

END OF SECTION

23 26 13.00 Pipe Expansion Joints, Guides and Anchors

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Select hangers, supports, anchors, guides and restraints to withstand all static and dynamic loading conditions which act upon the piping system and associated equipment. Design expansion and contraction solution to suit the temperature and spatial restraints of the location where the pipes are installed. Prepare detailed Shop Drawings showing all anchors, guides, and expansion compensation for all systems with the potential for thermal expansion/contraction and/or loads due to weight or thrust. Provide Shop Drawings bearing the signed seal of a Professional Engineer licensed to practice in the appropriate discipline and Place of the Work. Include in the Shop Drawings all details of construction, static and dynamic forces at points of attachment, etc. necessary for review and acceptance by the Project Structural Engineer's Representative. Make adjustments as necessary to satisfy the requirements of the Structural Division. Do not install any anchor points without reviewed Shop Drawings and, where installed prior to review, remove and replace to the satisfaction of the Engineer's Representative.

1.2. SYSTEM TEMPERATURES

1.2.1. Refer to schematics on Drawings for required operating pressures.

1.2.2. Base Shop Drawings required above on the following minimum and maximum temperatures.

System Type	Minimum Temperature	Maximum Temperature	Notes
Heating Water	4 C	115 C	Max temperature includes safety factor
Chilled Water	4 C	45 C	
Condenser Water	4 C	49 C	
Domestic Cold Water	4 C	45 C	
Domestic Hot Water / Recirculation	4 C	70 C	
Steam	4 C	198 C	
Condensate	4 C	100 C	

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

- 2.1.1. Expansion joints, guides and anchors: United Flexible, Flexonics, Hydroflex, or Victaulic, specifically designed for the system in which they are installed.
- 2.1.2. Victaulic Floor-Mounted Riser Anchor for Grooved Steel Piping: Engineered pipe anchor, sizes 50 mm (2 in.) through 300 mm (12 in.), standard weight carbon steel to ASTM A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless" with orange enamel coating with carbon steel brackets. Victaulic Original-Groove System grooved ends. Anchors suitable for system operating pressure to 3447 kPa (500 psi). Victaulic No. A10.
- 2.1.3. Victaulic AGS Heavy Riser Anchor: Engineered pipe anchor, sizes 350 mm (14 in.) through 600 mm (24 in.), standard weight carbon steel to ASTM A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless" with orange enamel coating with carbon steel brackets. Victaulic Advanced-Groove System (AGS) grooved ends. Anchors suitable for system operating pressure to 3447 kPa (500 psi). Victaulic No. WA20.
- 2.1.4. Victaulic Floor-Mounted Riser Anchor for Grooved Stainless Steel Piping: Engineered pipe anchor, sizes 50 mm (2 in.) through 300 mm (12 in.), schedule 40 stainless steel to ASTM A312 "Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes," type 304 with carbon steel brackets. Victaulic Original-Groove System grooved ends. Anchors suitable for system operating pressure to 3447 kPa (500 psi). Victaulic No. A10S.
- 2.1.5. Expansion compensation:
- .1 Expansion compensation solution as presented per Part 1 requirements.
 - .2 Expansion joints for 75 mm (3 in.) diameter pipe and larger: packless bellows type with equalizing rings, stainless steel bellows, limit stops, internal telescoping sleeves and carbon steel schedule with bevelled welding ends, or flanged to suit installation.
 - .3 Expansion joints for 65 mm (2-1/2 in.) diameter pipe and smaller: packless bellows type with stainless steel bellows, anti-torque device, limit stops, guides and threaded pipe ends.
 - .4 Grooved expansion joints for 20 mm (3/4 in.) and larger sizes: expansion joint consisting of a series of grooved end nipples joined with flexible-type couplings. Joint movement and expansion capabilities determined by number of couplings / nipples used in the joint. Victaulic Style 155, 155P and W155 AGS.
 - .5 Furnish an inspection and data report, furnish with expansion compensation system.

3. Execution

3.1. INSTALLATION

- 3.1.1. Provide for the expansion and contraction of all pipes, and install with sufficient flexibility to prevent end thrust and movements caused by thermal expansion or contraction causing detrimental distortion or damage of connected equipment. Provide offsets between mains and equipment of sufficient length to safely absorb the expansion of the main.
- 3.1.2. During operation, the chilled water supply temperature will be 4 deg. C. (39 deg. F.). Precompress expansion joints in accordance with manufacturer's installation instructions based on the ambient installation temperature.
- 3.1.3. Guides shall be as shown and shall be located as follows:

- .1 Distance from expansion joint to first guide shall be maximum 4 pipe diameters
- .2 Distance from first to second guide shall be maximum 14 pipe diameters
- .3 Maximum spacing between additional guides:
 - .1 3.7 m for 65 mm (12 ft. for 2-1/2 in.) pipe
 - .2 7.3 m for 75 mm and 100 mm (24 ft. for 3 in. and 4 in.) pipe
 - .3 11 m for 125 mm and 150 mm (36 ft. for 5 in. and 6 in.) pipe
 - .4 14.6 m for 200 mm (48 ft. for 8 in.) pipe
 - .5 18.3 m for 250 mm (60 ft. for 10 in.) pipe
- 3.1.4. Anchors shall be as shown.
- 3.1.5. Ensure anchors, expansion compensation, and guides are located and installed in accordance with the Engineered Shop Drawings required by this specification section.
- 3.1.6. Expansion joint and anchor manufacturer to provide on-site inspection to ensure proper installation per design requirements and manufacturer's installation instructions.

END OF SECTION

23 26 16.00 Flexible Pipe Connectors

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Pipe connectors, where shown, for water, shall be Hydroflex Hose, Flexonics or Vibro-Flo or corrugated metal with braided sheath.

2.1.2. Corrugated metal and sheath shall be of bronze or stainless steel with threaded ends for 50 mm (2 in.) pipe size and smaller and flanged ends for larger sizes.

2.1.3. Total length of connector shall vary from a minimum of 300 mm (12 in.) for 25 mm (1 in.) deflection, and up to 450 mm (18 in.) for 50 mm (2 in.) or greater deflection.

2.1.4. Minimum working pressure at 21.1 deg. C. (70 deg. F.) shall be 1200 kPa (175 psi) based on maximum working pressure not exceeding burst pressure.

3. Execution

3.1. NOT USED

END OF SECTION

23 31 13.00 Ductwork and Specialties

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Shop Drawings

- .1 Submit Shop Drawings of all catalogued components to be supplied. Include manufacturer's data sheets for certification, performance criteria, ratings, and physical dimensions and finishes.
- .2 Submit Shop Drawings of each supporting structural assembly required in the ductwork systems, designed by an engineer licensed to practice in the Place of the Work in the appropriate discipline. Same design engineer stamps each and every Shop Drawing.

1.2.2. Samples: Submit samples as required.

1.2.3. Submit marked up prints showing detailed locations of all devices mounted in or on ductwork, dimensioning their locations.

1.3. QUALIFICATIONS

1.3.1. Acceptable sheet metal trade specialists are limited to following:

- .1 Engie
- .2 Modern Niagara (DMC Mechanical Ltd.)
- .3 Smith & Long (Giffin Sheetmetal Ltd.)
- .4 J.C. Rogers
- .5 Black & MacDonald
- .6 Tam-Kal
- .7 David C. Little Contracting Inc.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Fabricate all ductwork unless specifically noted otherwise, of galvanized sheet steel with Z180 coating to A653/A653M.

2.1.2. Sealing compound: Minnesota Mining and Manufacturing or other approved manufacturer. Duct tape shall be Duro-Dyne or other approved manufacturer.

2.1.3. Flexible ducting:

- .1 Flexible fabric ducting shall be Flexmaster Fabriflex FAB-4. ULC listing S110.
 - .2 Flexible metal ducting shall be Flexmaster Triple-Lock Aluminum Flexible ducting T/L. ULC listing S110.
 - .3 Acoustic flexible metal ducting shall be Flexmaster Triple-Lock Acoustic Flexible ducting T/L-A-T/L consisting of perforated aluminum inner core, 38 mm (1-1/2 inch) insulation, and aluminum outer covering. ULC listing S110.
 - .4 Thermal flexible metal ducting shall be Flexmaster Triple-Lock Thermal Flexible T/L-M ducting ULC listing S110.
- 2.1.4. Access Ports shall be Lawson-Taylor or other approved manufacture of 32 mm (1-1/4 in.) dia. ports.
- 2.1.5. Flexible Connections:
- .1 Ventfabrics, Duro Dyne, or Dyne-Air.
 - .2 For fans less than 0.5 kPa (2 in. wg.) connections shall be minimum 680 gm/sq.m. (20 oz./sq.yd.) fire retardant polyvinyl-chloride polyester fabric equal to Vinyl-Flex.
 - .3 For fans in excess of 0.5 kPa (2 in. wg.) connections shall be minimum 1,080 gm/sq.m. (32 oz./sq.yd.) non-toxic neoprene coated fibreglass fabric equal to Neoprene N.T.
 - .4 For all flexible connections located outside the building (e.g. roof top units) flexible connections shall be fire retardant Hypalon coated fibreglass fabric and shall be a minimum 9915 gm/sq.m. (27 oz./sq.yd.) equal to Hypalon.
 - .5 For all systems where the temperature may exceed 112 deg. C. (235 deg. F.) silicone rubber coated fibreglass shall be used, and shall be equal to Silicone H1-T. Submit flexible connections for review before installation.
- 2.1.6. Dampers:
- .1 Dampers: For right angle branch duct take-off from vertical riser; Air vector Vectrol or other approved manufacturer.
 - .2 Construct fire dampers, smoke dampers and combination smoke and fire dampers of stainless steel where dampers are installed in aluminum or stainless steel ductwork.
 - .3 Fire Dampers: Underwriters' Laboratories Classified to ANSI/UL 555 Standard for Fire Dampers and CAN/ULC S112 Standard Method of Fire Test of Fire Damper Assemblies or ANSI/UL 555C Standard for Ceiling Dampers as applicable.
 - .1 Fire dampers shall be curtain type, rated as "Dynamic," and shall have the blades clear of the air stream. Fire dampers shall be Type B or Type C as required to suit system air velocity and pressure. Fire dampers in return and exhaust systems may be Type A with the blades in the air stream where permitted by the Engineer's Representative. Dampers shall be multi-sectional as required to suit size and UL/ULC Listing requirements. Where the specified curtain fire dampers are limited by the UL/ULC Listing for maximum size, they shall be substituted with multi-blade type complete with power actuation and/or fusible link as required to satisfy the fire rating of the partition. Where a fire damper is required to be installed behind a wall grille, Slimline type dampers may be used to provide a flush to wall grille installation.
 - .2 Fire-stop flaps or ceiling mounted fire dampers shall be as shown in the Underwriters' Laboratories Listing for the specific ceiling assembly used.
 - .3 Thermally insulated motorized control dampers: in accordance with the requirements contained within Section 23 09 00 – BUILDING AUTOMATION SYSTEM (BAS).

- .4 Combination balancing/fire damper: Combination balancing device and fire damper, in one Product, tested in accordance with ULC S112 "Standard Methods of Fire Test of Fire-Damper Assemblies", appropriate for use in fire separations of up to 2 hours.
- .5 Combination Smoke and Fire Dampers: Multi-blade type complete with operating shaft, stainless steel side seals and fire resistant insulating blade seals. Dampers shall bear label corresponding to fire rating shown on the Architectural Drawings and shall be of the same manufacturer as noted for fire dampers. Damper shall be opened/closed by electric damper actuator and fully closed on activation of electric temperature sensing device. Limit switches shall be provided to show position of damper blades. Leakage through dampers shall not exceed 40.6 L/s/ sq.m. (8 cfm/sq.ft.) of damper area at 1.0 kPa (4.0 in. wg.) of differential pressure when determined in accordance with CAN/ULC S112.1 "Leakage Rated Dampers for Use in Smoke Control Systems." Submit test data with Shop Drawings.
- .6 Smoke Dampers: Similar to dampers described above but without electric temperature sensing device.
- .7 Provide integral smoke detector as part of combination smoke and fire dampers, and smoke dampers required above. Provide integral smoke detector that is rated for zero flow.
- .8 Actuators For Combination Smoke and Fire Dampers and Smoke Dampers, Electronic:
 - .1 Actuator Type: Modulating.
 - .2 Control Signal: Compatible with fire alarm system and BAS.
 - .3 Power: Where a 120 V circuit is provided by the Electrical Contractor, provide a 120:24 V transformer, where required based on the actuator in question.
 - .4 Operating Time: Maximum 75 seconds throughout the full rotation.
 - .5 Angle of Rotation: Adjustable between 0° to 90°.
 - .6 Stall protection: Mechanical or electronic.
 - .7 Provide actuators with electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation.
 - .8 Failsafe: Spring return. Spring return to normal position within 10 seconds.
 - .9 Manual Override: Crank type.
 - .10 Position Indicator: Reversible for clockwise or counter-clockwise rotation; set the 0 degrees mark to the failsafe position.
 - .11 Torque: To damper manufacturer's requirements to provide complete compression of seals between frame and blades and for smooth control.
 - .12 Provide 2 SPDT auxiliary switches to prove open-closed.
 - .13 Provide electric temperature sensing device with damper actuators for all combination smoke and fire dampers. Temperature sensing device shall be ULC listed and suitable for UL 555S "Smoke Dampers" smoke and fire damper application.
 - .14 Provide UL 555S "Smoke Dampers" listed damper actuators for all dampers used in smoke control. All actuators shall be factory installed on dampers.
 - .15 Listed to UL 2043 "Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces."
- .9 Positive Seal Shut-off Dampers:
 - .1 Isolation type, positive seal, bubble tight damper at a differential pressure of 2.5 kPa (10 in. wg.). Damper shall be constructed with 1.9837 mm (0.0781 in - 14 USS gauge) thick, Type 304 stainless steel dish shaped disc with a knife-edge

- that seals against a T-304 stainless steel frame. The frame shall have a closed-cell neoprene rubber gasket that creates a gasket-to-knife edge seal. The damper shall have a $\frac{1}{4}$ turn worm-gear actuator with handwheel. The actuator shall have an aluminum base and cover. The rated torque shall be 225 Joules (2,000 in. lbs.) with a gear ratio of 30:1. The actuator shall be fully lubricated and self-locking.
- .2 The damper shall be all weld design, all pressure retaining weld joints and seams shall be continuously welded. Weld joints and seams requiring only intermittent welds by design shall not be continuously welded interior weld joints, where possible, shall be continuously welded to provide a smooth interior design, as a minimum, all welds shall be wire brushed and/or buffed to remove heat discoloration, burrs and sharp edges. All welding procedures, welders, and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX. All production welds shall be visually inspected in accordance with standard procedure incorporating the work acceptance criteria in Section 5 and 6 of ANSI/ANWS D9.1-1990 Specification of Welding of Sheet Metal.
- .10 Fabricate manual duct dampers as shown on Standard Details from galvanized steel 1.26 mm thick (0.048 in - 18 GSG gauge) or heavier. Dampers for ducts up to 300 mm (12 in.) deep shall be one blade carried on a 9 mm (3/8 in.) square steel rod mounted inside the duct. Dampers for ducts of greater depth than 300 mm (12 in.) shall be multi-blade, opposed-acting type, and shall have blades mounted in 38 mm (1-1/2 in.) steel channel frame, and interconnected for operation from one locking type hand quadrant. Dampers for right angle take-off of branch from vertical riser shall have operator extended to an accessible location. For externally insulated ducts, mount quadrant on a bracket, designed to clear the insulation. All dampers shall have indicator to show position of damper blade.
- .11 Fabricate splitter dampers as shown on Standard Details from at least the same thickness of galvanized steel as the duct in which it is installed, down to a minimum of 0.95 mm thick (0.0374 in - 20 GSG gauge). Fabricate of double thickness so that the entering edge presents a round nose to the air flow, and mount securely on hinges at the air leaving edge. Length of splitter shall be at least 1-1/2 times the width of the smaller branch duct, but in no case less than 300 mm (12 in.) long. Attach splitter hinge near the air entering edge with support passing through a clamp on the side of the duct, located where it is most accessible for external adjustment and locking of the damper.
- .12 Counterbalanced backdraft dampers shall be multi-blade louvre type, constructed of extruded aluminum in extruded aluminum frames with adjustable coated counterbalance weights. Blades shall be joined with a tie bar and have rust-proof shafts rotating in synthetic bearings.
- .13 Motorized dampers for Control Operation: In accordance with applicable requirements control systems (pneumatic) or central energy management systems section.
- 2.1.7. Interior Duct Protective Coating: Chlorinated rubber base paint or Eisenheiss Black.
- 2.1.8. Hardware and Accessories:
- .1 Spin-in connections shall be specifically built for that purpose. Dampers shall be a minimum 1 gauge heavier than the ductwork in which it is installed and shall have a full length shaft pivoted at two diametrically opposed points. An indicator shall be attached to the shaft to indicate the damper position.
- .2 Hardware for balancing or splitter dampers shall be rattle-free and leak resistant. Bearing rods shall be sized to suit the damper size. Neoprene seals shall be used to minimize leaks. Hardware shall be Dyn-Air or equal.

- .3 Provide single thickness turning vanes built to and supported at intervals dictated by SMACNA HVAC Duct Construction Standards Metal and Flexible. Provide rails securely set in the elbow so that they cannot loosen.
- 2.1.9. Provide following duct penetrations with barred duct inserts to restrict passage for minimum and maximum security applications:
 - .1 Barred ductwork insert shall be 5 mm (3/16 in.) welded steel on all four sides with 19 mm (3/4 in.) solid round security bars on 150 mm (6 in.) centres with 65 mm x 5 mm (2-1/2 in. x 3/8 in.) security bars on sizes exceeding 300 mm (12 in.). Angle frame shall be 5 mm (3/16 in.) steel angle (one welded to unit and one shipped loose for field welding). Install per manufacturer's current installation instructions.
- 2.2. FABRICATION
- 2.2.1. Fabricate ductwork in accordance with applicable duct construction requirements of SMACNA.
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Make all laps in the direction of air flow. Use no sheet metal screws in the duct where it is possible to use rivets and bolts. Hammer down all edges and slips so as to leave smooth finished surface inside the ducts.
- 3.1.2. Brace and stiffen all ducts, and make tight so that they will not breathe, rattle, vibrate or sag. Cross-break all rectangular ducts with heights or widths of 300 mm (12 in.) or larger.
- 3.1.3. Where rectangular ducts are shown, round ducts may be substituted at the Contractor's option, provided there is sufficient room. Conversion from rectangular to round duct, sizing shall be as shown on charts in ASHRAE.
- 3.1.4. Hang all ductwork securely and in a rigid manner. Provide hangers in accordance with SMACNA Standard "HVAC Duct Construction Standards Metal and Flexible."
- 3.1.5. Where pre-engineered support systems are provided, provide systems that have been evaluated and certified by SMACNA as well as a 3rd party evaluation service. Ensure application of pre-engineered support systems comply with the limitations noted in the SMACNA and 3rd party certification documents for the specific product in question (e.g. maximum duct width, single tier trapeze only, etc.). Install pre-engineered support systems in strict conformance to the manufacturer's written installation instructions and the conditions of the SMACNA and 3rd party evaluation documents.
- 3.1.6. Support all vertical ducts at each floor, on all sides, with angle riveted to the ducts.
- 3.1.7. The following low pressure, medium pressure and high pressure duct construction is based on an ASHRAE method of construction, and gives a minimum standard of construction. Alternative ASHRAE or SMACNA duct construction is acceptable, provided it meets the minimum standards as outlined by these Specifications. Submit proposed alternatives for review prior to fabrication.
- 3.1.8. Low pressure ductwork 0.5 kPa (2 in. wg) static pressure and less as follows:
 - .1 Rectangular/round duct location:
 - .1 Ductwork serving fans with an external static pressure of 0.5 kPa (2 in. wg) or less.
 - .2 Downstream of terminal heating and cooling devices.

- .2 Seal ducts to Seal Class C in accordance with SMACNA "HVAC Duct Construction Standards Metal and Flexible" and "HVAC Air Duct Leakage Test Manual."
 - .3 SMACNA leakage class:
 - .1 Rectangular ductwork: 16
 - .2 Round ductwork: 8
 - .4 Refer to tables for low pressure rectangular duct construction and round duct construction below for further duct construction requirements.
- 3.1.9. Medium pressure ductwork greater than 0.5 kPa (2 in. wg) and less than 1.5 kPa (6 in. wg) static pressure as follows:
- .1 Rectangular/round duct location:
 - .1 Ductwork serving fans with an external static pressure greater than 0.5 kPa (2 in. wg) and less than 1.5 kPa (6 in. wg).
 - .2 Smoke exhaust systems.
 - .3 Life safety pressurization systems.
 - .4 Refer to Section 23 31 16.29 – SPECIAL DUCTWORK for additional requirements.
 - .2 Seal ducts 1 kPa (4 in. wg) and greater static pressure to Seal Class A and 0.75 kPa (3 in. wg) static pressure to Seal Class B in accordance with SMACNA "HVAC Duct Construction Standards Metal and Flexible" and "HVAC Air Duct Leakage Test Manual."
 - .3 SMACNA leakage class:
 - .1 Rectangular ductwork:
 - .1 1 kPa (4 in. wg) and greater static pressure: 4
 - .2 0.75 kPa (3 in. wg) static pressure: 8
 - .2 Round ductwork:
 - .1 1 kPa (4 in. wg) and greater static pressure: 2
 - .2 0.75 kPa (3 in. wg) static pressure: 4
 - .4 Refer to tables for medium pressure rectangular duct construction and round duct construction below for further duct construction requirements.
- 3.1.10. High pressure ductwork 1.5 kPa (6 in. wg) static pressure and greater as follows:
- .1 Rectangular/round duct location:
 - .1 Ductwork serving fans with an external static pressure of 1.5 kPa (6 in. wg) and greater.
 - .2 Laboratory exhaust systems.
 - .3 Dust collector systems.
 - .4 Welding exhaust systems.
 - .5 Refer to Section 23 31 16.29 – SPECIAL DUCTWORK for additional requirements.
 - .2 Seal ducts to Seal Class A in accordance with SMACNA "HVAC Duct Construction Standards Metal and Flexible" and "HVAC Air Duct Leakage Test Manual."
 - .3 SMACNA leakage class:
 - .1 Rectangular ductwork: 4
 - .2 Round ductwork: 2

- .4 Refer to tables for high pressure rectangular duct construction and round duct construction below for further duct construction requirements.

3.1.11. Comply with the tables below in conjunction with the clauses above.

TABLE 1: LOW PRESSURE RECTANGULAR DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	TRANSVERSE JOINT CONNECTION AND BRACING
Up to 300 mm (12 in.)	26	Flat drive or flat 'S' no bracing
325 mm to 425 mm (13 in. to 18 in.)	24	Flat drive or flat 'S' no bracing
475 mm to 750 mm (19 in. to 30 in.)	24	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
775 mm to 1050 mm (31 in. to 42 in.)	22	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
1075 mm to 1200 mm (43 in. to 48 in.)	22	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
1225 mm to 1350 mm (49 in. to 54 in.)	22	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
1375 mm to 1500 mm (55 in. to 60 in.)	20	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
1525 mm to 2100 mm (61 in. to 84 in.)	20	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
2125 mm to 2400 mm (85 in. to 96 in.)	18	50 mm (2 in.) standing 'T' bracing 38 mm x 38 mm x 5 mm (1-1/2 in. x 1-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
2425 mm to 3000 mm (97 in. to 120 in.)	18	50 mm (2 in.) standing 'T' bracing 50 mm x 50 mm x 6 mm (2 in. x 2 in. x 1/4 in.) at maximum 600 mm (24 in.) centres.
3025 mm and over (121 in. and over)	18	As above with addition of tie rods at 300 mm (120 in.) centres for joint bracing.
.1 Bracing spacing shown is maximum spacing between two bracings or between bracing and joint. .2 Locate bracings mid-way between joints. .3 Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.		

TABLE 2: MEDIUM PRESSURE RECTANGULAR DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	TRANSVERSE JOINT CONNECTION & BRACING
Up to 300 mm (12 in.)	24	25 mm (1 in.) standing seam, 16 mm (5/8 in.) welded flange 25 mm (1 in.) pocket lock, no bracing.
325 mm to 425 mm (13 in. to 18 in.)	24	25 mm (1 in.) standing seam, 22 mm (7/8 in.) welded flange, 25 mm (1 in.) pocket lock, bracing 25 mm x 25 mm x 16 gauge (1 in. x 1 in. x 16 UG gauge) at 1200 mm (48 in.) centres.
475 mm to 600 mm (19 in. to 24 in.)	22	32 mm (1-1/4 in.) standing seam, 35 mm (1-3/8 in.) welded flange, 30 mm (1-1/8 in.) pocket lock, bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 120 mm (48 in.) centres.
625 mm to 900 mm (25 in. to 36 in.)	22	38 mm (1-1/2 in.) standing seam, 38 mm (1/2 in.) pocket lock, bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 120 mm (48 in.) centres.
925 mm to 1200 mm (37 in. to 48 in.)	22	50 mm (2 in.) standing seam or 50 mm (2 in.) flanged joint, bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 750 mm (30 in.) centres.
1125 mm to 1500 mm (49 in. to 60 in.)	20	38 mm (1-1/2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 600 mm (24 in.) centres.
1525 mm to 1800 mm (61 in. to 72 in.)	20	38 mm (1-1/2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 600 mm (24 in.) centres.
1825 mm to 2100 mm (73 in. to 84 in.)	18	50 mm (2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
2425 mm and over (96 in. and over)	18	50 mm (2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
.1 Bracing spacing shown above is maximum spacing between two bracings or between bracing and joint. Locate bracing mid-way between joints. .2 Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.		

TABLE 3: HIGH PRESSURE RECTANGULAR DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	CONSTRUCTION
Up to 300 mm (12 in.)	22	Flanged angle gasketed joint or butt welded joint with 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) angle.
325 mm to 450 mm (13 in. to 18 in.)	22	Flanged angle gasketed joint or butt welded joint with flanged angle 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) and reinforcing angle 25 mm x 25 mm x 16 US gauge (1 in. x 1 in. x 16 US gauge) at maximum 1200 mm (48 in.) centres.
475 mm to 600 mm	22	Flanged angle gasketed joint or butt welded joint with flanged angle 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) and reinforcing angle 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
625 mm to 900 mm (25 in. to 36 in.)	22	Flanged angle gasketed joint or butt welded joint with flanged angle 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) and reinforcing angle 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) at maximum 800 mm (32 in.) centres.
925 mm to 1200 mm (37 in. to 48 in.)	22	Flanged angle gasketed joint or butt welded joint with flanged angle 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) and reinforcing angle 65 mm x 65 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 750 mm (30 in.) centres.
1225 mm to 1500 mm (49 in. to 60 in.)	20	Flanged angle gasketed joint or butt welded joint with flanged angle 50 mm x 50 mm x 5 mm (2 in. x 2 in. x 3/16 in.) and reinforcing angle 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
Over 1500 mm (60 in.) and all sizes between fan and round duct	20	Flanged angle gasketed joint or butt welded joint with flanged angle 50 mm x 50 mm x 5 mm (2 in. x 2 in. x 3/16 in.) and reinforcing angle 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.

TABLE 4: ROUND DUCT CONSTRUCTION

1. Round ducts up to 750 mm (30 in.) diameter factory fabricated, helically wound galvanized iron strips with spiral lock seam.			
DIAMETER	STRIP METAL US GAUGE	STRIP JOINT	GIRTH JOINT
Up to 200 mm (8 in.)	26	100 mm (4 in.)	50 mm (2 in.) long slip
225 mm to 550 mm (9 in. to 22 in.)	24	100 mm (4 in.)	50 mm (2 in.) long slip
575 mm to 750 mm (23 in. to 30 in.)	22	150 mm (6 in.)	100 mm (4 in.) long slip

Join with galvanized iron coupling sleeves or conduit fittings of welded construction.

Construct larger ductwork as follows with longitudinal lock or butt welded seams:

DIAMETER	SHEET METAL US GAUGE	REINFORCING	GIRTH JOINT
775 mm to 900 mm (31 in. to 36 in.)	20	None	100 mm (4 in.) long slip
925 mm to 1500 mm (37 in. to 60 in.)	18	32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) angle on max 1800 mm (72 in.) centres	32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in. angle flanged.

- 3.1.12. Seal all joints of all ducts. Brush joints with the compound before and again after assembly. Seal any leaks causing noise.
- 3.1.13. Seal the bottom and side joints of outside air ducts or plenums water-tight.
- 3.1.14. Flexible duct shall be connected to sheet metal duct and diffusers using duct sealer, minimum of two screws separated by 180 degrees and metal draw bands. Duct tape is not acceptable.
- 3.1.15. Flexible ductwork may be used under the following conditions:
- .1 Where shown on Drawings to allow easy location of diffusers.
 - .2 Except where indicated otherwise in clauses below, minimum length of flexible duct used to connect diffusers and interior troffers: 2,400 mm (84 in.).
 - .3 Except where indicated otherwise in clauses below, maximum length of flexible duct: 3,000 mm (120 in.).
 - .4 Do not pass flexible ductwork through floors or fire walls.
 - .5 Install flexible ductwork as a single section of duct (no joints). In the event that building construction requires connection between lengths of flexible duct, use a rigid section of duct as the joint. Secure flexible duct to the rigid section using ties and sealant.
 - .6 Support flexible duct lengths greater than 2,400 mm (84 in.) at the midpoint with strap hangers.
 - .7 Within residential suites, flexible ductwork may be used under the following conditions:

- .1 Exhaust ductwork connected to wall box using a maximum of 914 mm (36 in.) of flexible ductwork. Flex duct not permitted on outside air ductwork.
- 3.1.16. Where ductwork passes through a wall or floor, other than when a fire damper is required, pack around the duct using a fire resistant material to ensure a sound and airtight joint.
- 3.1.17. If changes of size of ducts are necessary because of building construction, maintain the same circular equivalent for the new size. Ratio of the longest side of the duct to the least shall not exceed 4 to 1 unless specifically authorized by the Engineer's Representative.
- 3.1.18. Select the gauge of metal and method of construction for the new size. Notify the Engineer's Representative of any change before such changes are incorporated into the Work.
- 3.1.19. If changes of location of duct are required because of building construction, review with the Engineer's Representative before the locations indicated are changed in any way.
- 3.1.20. Make changes of direction of horizontal ducts with elbows having an inside radius not less than 3/4 the width of the duct. Make change of direction from horizontal to vertical duct with elbows having an inside radius equal to the depth of the duct. Where this is not possible due to the building construction, use turning vanes.
- 3.1.21. Provide access ports at convenient locations in all main ducts and main branch take-offs with airtight covers and extension sleeves through insulation to allow air meter readings. Access ports shall be approved by the Engineer's Representative and the testing company before installation.
- 3.1.22. Provide flexible connections at each air handling unit (where not provided internally) and fan duct connections before and after any required transitions on the fan inlet and outlet respectively (i.e. on the largest duct perimeter and not directly installed on the fan inlet and outlet to reduce noise and air turbulence).
- 3.1.23. Install manual duct dampers as shown on Standard Details. Ensure dampers for right angle take-off of branch from vertical riser have operator extended to an accessible location. Adjust quadrants to clear duct insulation.
- 3.1.24. Provide splitter dampers as shown on Standard Details.
- 3.1.25. Incorporate counterbalanced backdraft dampers where shown. Adjust counterweights to the minimum pressure required to relieve the system pressure. Incorporate gravity backdraft dampers where shown.
- 3.1.26. Install motorized dampers where directed.
- 3.1.27. Install fire dampers where shown and at all penetrations through all fire rated assemblies. Provide firestop flap type fire dampers where fire dampers are shown in grilles or diffusers at ceiling level. Provide the appropriate fire damper model to suit the installation condition and provide all necessary flanges, frames, fittings, and accessories to ensure a flush installation. Obtain local authorities' approvals for all damper locations and keep one set of marked-up prints on site. Approvals shall be obtained before installation of fire dampers.
- 3.1.28. Where a fire damper is required to be installed behind a wall mounted grille, provide damper, angles, and retaining devices as required to provide a smooth, flat to wall installation.
- 3.1.29. Where fire dampers for ducts shown on Drawings require a change of type and/or powered actuation due to dimension limitations to satisfy the cUL Classification requirements, provide transitions as required to adjust duct dimensions while maintaining the equivalent circular duct diameter to avoid exceeding any specific listed maximum dimension. Where transitions are not possible or dimensions cannot be adjusted to avoid powered actuation, provide power from the closest available emergency power source as required. Review all conditions with the Engineer's Representative in advance of fabrication.

- 3.1.30. Install combination smoke and fire dampers and smoke dampers where shown. Ensure operators are accessible for maintenance. Coordinate installation of required fire alarm connections with Electrical Contractor and provide wiring connections to BAS where required by damper sequence of operations. Coordinate connections to damper actuators in accordance with sequence of operations and damper locations.
- 3.1.31. Receive automatic dampers from separate Section on site, and set in place under the supervision of the control manufacturer.
- 3.1.32. Provide access panels at all fire dampers, gravity dampers, motorized dampers, coils, heaters, humidifiers, fan bearings or similar equipment requiring occasional maintenance or inspection. Panels shall be 600 mm x 450 mm (24 in. x 18 in.) or full width of duct if less than 450 mm (18 in.) wide. Panels shall be of double wall construction and shall be internally insulated on insulated ducts. Frame shall be of structural angle with welded corners, gasketed to receive the panel. Panel shall be held in place with 4 window sash locks.
- 3.1.33. Paint visible internal surface behind each grille or register flat black.
- 3.1.34. Where duct is acoustically lined, duct dimensions shown are net, inside of lining, free area dimensions.
- 3.1.35. Ductwork installed underground shall be round spiral sheet metal constructed in accordance with high pressure duct standards. Joints shall be sealed with high pressure duct sealant and taped. Duct shall be completely covered with a minimum of two coats of bitumastic coatings.
.1 Slope underground duct and provide drainage in accordance with the Building Code.
- 3.1.36. Intake and exhaust ductwork for indoor cooling towers shall be constructed the same as ductwork but the bottom section of the intake duct shall have extra reinforcing to support a mass of 100 kg (weight of 250 lbs) without deflecting. Provide a supporting steel angle frame to support the plenum from the floor.
- 3.1.37. Provide internal acoustic duct lining in accordance with Section 20 05 48.00 – VIBRATION AND NOISE CONTROL.
- 3.1.38. Air wells shall be 1.95 mm thick (0.0767 in - 14 GSG gauge) galvanized steel construction with all joints welded. Clean all welds so that no water traps occur. Touch-up all welds with zinc rich primer. Suitably brace the entire assembly with steel angle to prevent flexing and drumming. Coat the entire surface exposed to the outside air with 2 coats of rustproofing finish. Submit sample of rustproofing for review. Provide a structural supporting frame to support the entire unit plus an additional live loading of 4.2 kg/sq.m. (100 lbs/sq.ft.).
- 3.1.39. Spin-in connections shall only be used downstream of variable volume boxes.
- 3.1.40. Ductwork shall be run parallel to the closest wall. Coordinate with piping and structural elements.
- 3.1.41. All exposed open ends of ductwork located less than 2000 mm (79 in) above the finished floor that do not have a diffuser, grille or register shall have a protective screen mounted in a suitable frame to connect the screen securely to the duct, wall and floor as applicable. The screen shall be installed and painted matte black and shall not be capable of passage of anything larger than a 15 mm (1/2 in.) sphere through the openings.
- 3.1.42. Supply air ductwork to variable volume boxes shall be rigid duct of size shown in schedules. If the length exceeds 3000 mm (10 ft.) or if there are 2-45 deg. elbows or 1-90 deg. elbow or more increase the supply air ductwork to the variable volume box one size. If the length exceeds 6000 mm (20 ft.) increase the duct by two sizes. Under no conditions shall the supply ductwork exceed 9000 mm (30 ft.) or have more than 3-90 deg. elbows or the equivalent. Transition to variable volume box inlet sizes a minimum of 4 duct diameters upstream of the terminal unit.

- 3.1.43. Where acceptable to Engineer's Representative, and where fans shut down upon detection of fire, static fire dampers may be used in lieu of dynamic fire dampers.

END OF SECTION

23 34 63.00 Roof Mounted Fans

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Electrical hard wire supply and primary connections to electrical components - under Electrical Division.

1.2.2. Supply and installation of built-up wood curb and flashings - under Section 06100 and 07600.

1.3. SUBMITTALS

1.3.1. Shop Drawings:

- .1 Submit Shop Drawings of all roof mounted fans with catalogued components to be supplied. Include manufacturer's data sheets for all fans at specified airflow, performance criteria, ratings, and physical dimensions and finishes. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted. Provide outlet velocity and both inlet and outlet sound power readings for the eight octave bands.

1.3.2. Manufacturer's Data:

- .1 Conform to AMCA Standards 205 "Energy Efficiency Classification for Fans," 211 "Certified Ratings Program - Product Rating Manual for Fan Air Performance," and 311 "Certified Ratings Program - Product Rating Manual for Fan Sound Performance". Test fans in accordance with ANSI/AMCA Standard 210 "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating" and AMCA Standard 300 "Reverberant Room Method for Sound Testing of Fans" in an AMCA accredited laboratory and provide bearing the AMCA seal for air and sound performance.
- .2 Conform to AMCA 99 "Standards Handbook" for Classification for Spark Resistant Construction.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Except as otherwise indicated, provide roof mounted fans by Cook, FlaktWoods, Greenheck, PennBarry or Twin City.

2.1.2. For all fans, comply with UL/cUL 705 "Power Ventilators."

- .1 For all fans used in machinery room ventilation systems where A2L class refrigerants are used, provide fans complete with electric motors outside the air stream and non-ferrous or spark resistant fan rotating elements.

- 2.1.3. For all fans used for smoke control, provide fans that are UL/cUL listed and tested for operation at 260 Deg. C. (500 Deg. F.) for a minimum of four hours, and 520 Deg. C. (1000 Deg. F.) for a minimum of fifteen minutes.
- 2.1.4. Provide low silhouette fans of bolted and welded construction utilizing corrosion resistant fasteners. Enclose the fan with a galvanized steel hood with the entire assembly primed with a zinc rich primer or, an aluminum hood, treated to prevent corrosion. Bolt the hood to the fan housing and make removable to allow unobstructed access to the motor and power assembly. Provide aluminum base with continuously welded curb cap corners for maximum leak protection.
- 2.1.5. Provide dome type fans of bolted and welded construction utilizing corrosion resistant fasteners. Provide motor cover, shroud, curb cap, and lower wind band constructed of heavy gauge aluminum and treated to reduce corrosion. Provide aluminum base with continuously welded curb cap corners for maximum leak protection. Provide shroud with an integral rolled bead for added strength.
- 2.1.6. Provide wheel that is non-overloading centrifugal backward inclined, constructed of aluminum. Provide wheel inlet that overlaps an aerodynamic aluminum inlet cone or venturi to provide maximum performance and efficiency. Provide assembled wheel that is electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19 "Mechanical Vibration - Balance Quality Requirements Of Rigid Rotors - Part 1: Determination Of Possible Unbalance, Including Marine Applications."
- 2.1.7. Mount the motor, bearings and drives on a steel power assembly, isolated from the unit structure with rubber vibration isolators. Enclose these components in a weather-tight compartment, separated from the exhaust airstream.
- 2.1.8. Provide units complete with a galvanized bird screen treated to prevent corrosion.
- 2.1.9. Provide bearings that are heavy duty, grease lubricated, anti-friction ball or spherical roller, self-aligning, pillow block type and selected for a minimum L50 life in excess of 200,000 hours at maximum load.
- 2.1.10. Size blower shaft for a critical speed of at least 125 % of the maximum RPM.
- 2.1.11. Provide belts that are oil and heat resistant, non-static type. Provide drives that are precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Size drives for 150 % of the installed motor horsepower. Factory set the variable pitch motor drive to the specified fan RPM.
- 2.1.12. Coat all steel fan components with an electrostatically applied, baked polyester powder coating or other equivalent protective coating.
- 2.1.13. Provide motors in accordance with the requirements of Section 20 05 13.00 - ELECTRIC MOTORS. See Fan Schedule for hp (wattage) ratings.
- 2.1.14. Provide motor operated dampers under a separate Section as shown on Drawings and specified in Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS). Where motor operated dampers are not shown, provide gravity dampers at the fan by this Section.
- 2.1.15. Mount unit on a prefabricated roof curb to match the fan size. Provide flat curb for flat roofs and pitched curb to suit slope of roof for pitched roofs. Acoustically line all exhaust curbs, except for kitchen and laboratories. Provide unit that is nominally 610 mm (24 in.) high.
- 2.1.16. Provide vibration isolation as specified in Section 20 05 48.00 - VIBRATION AND NOISE CONTROL.
- 2.1.17. Provide roof mounted fans in accordance with the Fan Schedule.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install fans in locations shown on Drawings.
- 3.1.2. Align shafts, belt drive and motor, adjust belt tension, ensure all set screws are tight and check motor rotation before start-up.
- 3.1.3. Protect motors and fans during construction.

END OF SECTION

23 37 13.00 Diffusers, Grilles and Registers

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Continuous air slot in ceiling - under Division 9 - Finishes.

1.2.2. Door grilles - under Architectural Division - Grilles.

1.3. SUBMITTALS

1.3.1. Shop Drawings: Submit detailed Shop Drawings of all components furnished under this Section. Manufacturer to indicate ceiling installation type for each type of diffuser specified.

1.3.2. Manufacturer's Data: Submit test results of type " " diffuser models to be used on the Project, including air pattern and noise levels for air quantities from 10 % to 110 % of the required maximum air flow.

1.3.3. Sample of exposed duct detail. See mechanical standard details on the Drawings.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Acceptable manufacturers:

- .1 Price
- .2 Nailor
- .3 Krueger equal to the units specified
- .4 Titus equal to the units specified

2.1.2. Select diffusers to provide uniform air coverage without overlap. Base selection on air velocity of 0.127 to 0.254 m/s (25 to 50 fpm) up to a height of 1800 mm (6 ft.) above the floor.

2.1.3. Noise generated by diffusers: room sound pressure level not to exceed noise criteria 32 with a 10 dB room attenuation, the sound power level referenced to 10⁻¹² power watts.

2.1.4. Volume and air pattern devices: Do not provide dampers in the diffuser neck unless specifically indicated in the description or on the Schedule. Where dampers or air pattern devices are specified, include hardware to allow full adjustment from the face of the diffuser or air pattern device.

2.1.5. In gypsum board or plaster ceiling applications, provide matching mounting frame. Coordinate colour with the architect.

- 2.1.6. T-bar ceilings: coordinate diffuser compatibility with T-bar ceiling specified by the architectural division. Match the colour of ceiling tile in lay-in ceilings. Size to suit ceiling grid as required, imperial or metric.
- 2.1.7. Test Requirements: ASHRAE Standard 70, including air pattern and noise levels for air quantities from 10% to 110% of the required maximum air flow. Sound power tests measured in accordance with ASHRAE Standard 70 and NC ratings determined using a 10 dB room attenuation factor.
- 2.2. SQUARE SUPPLY DIFFUSERS
 - 2.2.1. Type P: Steel square plaque diffuser 600 mm x 600 mm (24 in. x 24 in.) face size consisting of a precision formed back cone of one piece seamless construction, a round inlet collar of sufficient length for connecting rigid or flexible duct as shown, a removable inner plaque assembly no more than 6.4 mm (1/4 in.) below the ceiling plane to assure proper air distribution performance.
 - .1 Price SPD
 - .2 Nailor UNI
 - 2.2.2. Type P1: As specified above but with 300 mm x 300 mm (12 in. x 12 in.) face size in a 600 mm x 600 mm (24 in x 24 in) panel for installation in ceiling specified by the architect.
 - .1 Price SPD
 - .2 Nailor UNI
 - 2.2.3. Type P2: As specified above except of aluminum construction for installation in areas of high humidity such as shower rooms, etc.
 - .1 Price ASPD
 - .2 Nailor AUNI
- 2.3. LINEAR SUPPLY AND RETURN DIFFUSERS
 - 2.3.1. Type S: linear supply diffusers of the sizes, configurations and mounting types required.
 - .1 Plenum Construction:
 - .1 Zinc coated steel
 - .2 6 mm (1/4 in.) internal insulation
 - .3 Sloped shoulders for enhanced spread (internal baffles are not acceptable)
 - .4 Mounting style suitable for ceiling type (drywall or T-Bar)
 - .5 Round side inlet of size indicated on the Drawings
 - .2 Diffuser Construction:
 - .1 Extruded aluminum boarder with mitred ends
 - .2 "Ice tong" style pattern controllers for 180 deg. pattern adjustment and black finish
 - .3 Concealed frame for drywall installation, T-Bar style for T-Bar ceilings
 - .4 Continuous installation to match Drawings and architectural look
 - .3 S1 Type: One slot, 19 mm (3/4 in.) slot
 - .4 S2 Type: Two slots, 19 mm (3/4 in.) slot
 - .5 S3 Type: Three slots, 19 mm (3/4 in.) slot

- .6 Return Sections: Parts of continuous diffusers that do not have a supply air boot shown are returns. They are indicated with an R on the Drawings. Refer to air terminal schedule on drawings for slot width, number of slots and overall length.
 - .1 In continuous installations, include the air pattern controller for supply boot flexibility.
 - .2 In non-continuous installation, provide a sight baffle in lieu of the pattern controllers.
- .7 Manufacturer:
 - .1 Price SDS/SDA
 - .2 Nailor Series 5000/5300
- 2.4. SILL, SIDEWALL AND FLOOR GRILLES
- 2.4.1. Type G: Heavy duty linear floor grille type with 3 mm x 19 mm (1/8 in. x 3/4 in.) extruded heavy duty aluminum bars on 6 mm (1/4 in.) centers for zero deflection. Install removable core in heavy duty floor frame. Set frame high enough to suit architectural floor covering.
 - .1 Price LBMH-15A.
- 2.5. WALL AND DUCT GRILLES
- 2.5.1. Type B: standard double deflection type with adjustable horizontal face bars and vertical rear bars.
 - .1 Construction: Steel double deflection with two sets of adjustable deflection blades, front blades parallel to the long dimension, spaced 19 mm (3/4 in.) on centre spacing.
 - .2 Finish: aluminum powder coat finish
 - .3 Damper: Opposed blade, of the same material as the grille, operable from the face.
 - .4 Manufacturer:
 - .1 Price 520(D)
 - .2 Nailor 5100 Series
- 2.5.2. Type B1: Same as above except of Aluminum construction for high humidity areas such as shower rooms.
 - .1 Manufacturer:
 - .1 Price 620(D)
 - .2 Nailor 5100 Series
- 2.5.3. Type B2: Same as above except of stainless-steel construction.
 - .1 Manufacturer:
 - .1 Price 720(D)
 - .2 Nailor 5100 Series
- 2.6. RETURN, EXHAUST AND TRANSFER GRILLES
- 2.6.1. Type E: Egg crate type of size shown on the Drawings.
 - .1 Construction:
 - .1 Aluminum egg crate core, 13 mm x 13 mm x 13 mm (1/2 in. x 1/2 in. x 1/2 in.) and extruded aluminum border.
 - .2 Finish: B12 white powder coat finish

- .3 Assembly suitable for T-Bar ceiling installation or wall installation as shown on the Drawings.
 - .2 Manufacturer:
 - .1 Price Series 80
 - .2 Nailor 5100 Series
- 2.6.2. Type K: Standard return grilles with horizontal fixed bars set at approximately 45 deg. for wall returns and set straight for ceiling return.
 - .1 Construction: Steel single deflection return grille with blades oriented parallel to the long dimension, spaced at 19 mm (3/4 in.) on centre.
 - .2 Finish: white powder coat finish
 - .3 Damper: Opposed blade, of the same material as the grille, operable from the face.
 - .4 Manufacturer:
 - .1 Price 530(D)
 - .2 Nailor 6100 Series
- 2.6.3. Type K1: Same as above except of aluminum construction.
 - .1 Manufacturer:
 - .1 Price 630(D)
 - .2 Nailor 6100 Series
- 2.6.4. Type K2: Same as above except of stainless-steel construction.
 - .1 Manufacturer:
 - .1 Price 730(D)
 - .2 Nailor 6100 Series
- 2.6.5. Type D: Heavy duty gym return grilles
 - .1 Construction:
 - .1 Heavy 14-gauge steel construction, horizontal fixed bars set parallel to the long dimension with 0 deg. deflection.
 - .2 Damper: Black key operated damper mounted behind grille operable from the face.
 - .3 Border: Heavy gauge flat steel border with concealed fasteners.
 - .4 Finish: White powder coat.
 - .2 Manufacturer:
 - .1 Price Series 90
 - .2 Nailor 6145H-HD
- 2.6.6. Type J: Transfer Grilles - Steel construction, standard single deflection fixed blade type, 45 deg. deflection, blades horizontal orientation, surface mount border with countersunk screw holes and oval head screws. Match finish to wall.
 - .1 Price model 535
 - .2 Nailor 6155H/V
- 2.6.7. Door transfer grilles: Finely spaced blades for an attractive sight proof appearance and designed for applications in doors or partitions with sections as thin as 35 mm (1-3/8 in.) with flat border and countersunk holes.
 - .1 Manufacturer:

- .1 Price ATG1
- .2 Nailor 51DGD

3. Execution

3.1. INSTALLATION

- 3.1.1. Refer to the Architectural Drawings for actual locations of diffusers, grilles and registers and install to suit these Drawings. The Mechanical Drawings show intent and number of diffusers, grilles and registers required.
- 3.1.2. Provide transfer grilles in all finished spaces where air is transferred through a ceiling or partition.
- 3.1.3. For exposed ductwork installations, oversize connections to grilles and in-turn flanges to meet the flange of the grilles and the duct. Out-turned or exposed flanges with screw mounting are not acceptable.
- 3.1.4. For special mounting of diffusers, grilles and registers, refer to Architectural Drawings.
- 3.1.5. Where diffusers, grilles or registers are installed in drywall or inaccessible ceilings, provide means of adjusting flow pattern, flow balancing and flow equalizing from the face of the diffuser.
- 3.1.6. Install mounting frame tied into plaster and gypsum board ceilings to allow lay in type diffusers to rest on the frame.
- 3.1.7. Lay diffusers on inverted T-bars spaced on ... mm (... in.) centers in T-bar ceilings.
- 3.1.8. Be responsible for mounting concealed flange linear diffusers in heated environment and following manufacturer's instructions.
- 3.1.9. Caulk around edges of linear diffusers in installations with imperfect walls.

END OF SECTION

23 41 16.00 Disposable Filters

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Filters shall be American Air Filter, Camfil Farr, Cambridge, Purafil, or Airguard

2.1.2. Pre-filter shall be constructed of galvanized steel frame, 3.0607 mm thick (0.1205 in - 11 gauge) galvanized wire grid and 50 mm (2 in.) thick disposable media. Filter shall have an Underwriters' Class 2 rating. Static pressure drop for a clean filter shall not exceed 0.042 kPa (0.17 in. wg.) for 944 L/s (2000 cfm) passing through a 600 mm x 600 mm (24 in. x 24 in.) filter.

2.1.3. Alternate Pre-filter efficiency filters shall be constructed with water resistant cell walls and non-woven cotton fabric media. Filters shall have any Underwriters' Class 2 rating. Filters shall be nominally 600 mm x 600 mm x 100 mm (24 in. x 24 in. x 4 in.) deep. Media shall have Minimum Efficiency Reporting Value of MERV 7. Media shall be supported on a wire mesh. Static pressure drop for filter for a nominal 944 L/s (2000 cfm) passing through a 600 mm x 600 mm (24 in. x 24 in.) filters shall be 0.06 kPa (0.25 in.wg.) initial and 0.25 kPa (1.0 in.wg.) final.

2.1.4. Final filters shall be supported pleated type constructed of water resistant, fireproof cell walls and spun glass media. Filters shall have an Underwriters' Class 2 rating. Filters shall be nominally 600 mm x 600 mm x 300 mm (24 in. x 24 in. x 12 in.) deep. Media shall have a Minimum Efficiency Reporting Value of MERV11, MERV 13, MERV14, or MERV15. Media efficiencies shall be as shown on Schedules. Static pressure drops for filter for a nominal 944 L/s (2000 cfm) passing through a 600 mm x 600 mm (24 in. x 24 in.) filter shall be as follows:

MEDIA	INITIAL	FINAL
MERV 11	0.10 kPa (0.39 in.wg.)	0.37 kPa (1.5 in.wg.)
MERV 13	0.14 kPa (0.56 in.wg.)	0.37 kPa (1.5 in.wg.)
MERV 14	0.14 kPa (0.58 in.wg.)	0.37 kPa (1.5 in.wg.)

2.1.5. Final filters shall extended surface bag filters with metal frame and spun glass bag filter media. Filters shall have any Underwriters' class 2 rating. Filters shall be nominally 600 mm x 600 mm x 900 mm (24 in. x 24 in. x 36 in.) deep with a gross media area of 104 ft². Media shall have a Minimum Efficiency Reporting Value of MERV12, MERV14, or MERV15. Media efficiencies shall be as shown on Schedules. Static pressure drops for filters for a nominal 944 L/s (2000 cfm) passing through a 600 mm x 600 mm (24 in. x 24 in.) filter shall be as follows:

MEDIA	INITIAL	FINAL

MERV 12	0.07 kPa (0.27 in.wg.)	0.25 kPa (1.0 in.wg.)
MERV 14	0.07 kPa (0.29 in.wg.)	0.25 kPa (1.0 in.wg.)
MERV 15	0.08 kPa (0.31 in.wg.)	0.25 kPa (1.0 in.wg.)

- 2.1.6. All bag filters shall be complete with a supporting frame to prevent assembly bag collapse under low-air flow or no-air flow conditions.
- 2.1.7. Each filter bank shall be complete with retainer and frames for assembly into a panel and complete with all miscellaneous fittings and gaskets to ensure a complete assembly.
- 2.1.8. Operate units with pre-filters during finishing time. Provide one complete set of new prefilters and final filters on date of acceptance of the building. Ensure all filters are installed before testing and balancing.
- 2.1.9. Prefilters shall be in conformance with the Prefilter Schedule.
- 2.1.10. Final filters shall be in conformance with the Final Filter Schedule.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install blank-off panels between filter banks and plenums to ensure no air by-pass occurs.

END OF SECTION

23 57 19.13 Heat Exchangers - Plate Type

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Plate type heat exchangers shall be Xylem, Alfa-Laval, Armstrong, Tranter, APV, Taco, GEA or AIC Inc. with fluids and performance in accordance with the Heat Exchanger Schedule.

2.1.2. Provide AHRI 400 certification for all fluids.

2.1.3. Construction shall consist of a carbon steel frame with one stationary cover and one moveable cover. The heat transfer plates and the moveable cover shall be suspended from an upper carrying bar and guided by a lower guiding bar, which are attached to the stationary frame plate and shall be easy to move after disconnection of the tightening bolts. The design shall permit ready access to the plate pack for inspection and cleaning and it shall permit removal of individual plates. Tightening bolts shall be galvanized carbon steel.

2.1.4. The frame parts shall be sandblasted and painted with a primer and a finishing paint.

2.1.5. The material for the heat transfer plates shall be stainless steel for all HVAC and potable water applications and titanium for units serving pool water.

2.1.6. For potable water and pool applications, provide double wall heat exchanger with two plates pressed together to create two fluid leak paths to atmosphere. Provide 0.35 mm plate thickness for each plate and 0.7 mm total thickness of two plates pressed together.

2.1.7. Gaskets shall be Nitrile or EPDM and suitable for the given fluids, pressures and temperatures.

2.1.8. The design, construction, inspection and testing shall comply with the applicable Provincial pressure vessel regulations. Submit certificates to the Engineer's Representative.

2.1.9. Provide CRN number and all required registration documentation for heat exchangers.

2.1.11. During manufacturing all tests and inspection required by applicable regulations and codes shall be performed to assure that material, workmanship, finish dimensions and markings are in accordance with the Specifications. The heat exchanger shall be subject to hydrostatic testing.

2.1.12. Provide two relief valves set at working pressure for each exchanger installed on headers to protect the plates. The pressure rating of the heat exchanger shall be greater than the working pressure noted in the Heat Exchanger Schedule assuming the one side is under pressure and the other side is empty of fluid. If nothing is noted, the rating shall be not less than 150 PSI. All units shall be tested to ASME standards and not less than 1.3 times the design pressure.

- 2.1.13. For units where both sides are part of a closed loop system, the heat exchangers shall be selected with a 0.0001 BTU/ft2hr.deg fouling factor for the unit (0.00005 BTU/ft2hr.deg.F. applied to each side) based on the capacities given in the Schedules.
 - 2.1.14. For units where one or both sides are part of an open loop system, the heat exchangers shall be selected with a 0.00025 BTU/ft2hr.deg fouling factor for the unit (0.000125 BTU/ft2hr.deg on each of the open side(s)) based on the capacities given in the Schedules. Examples of 'open systems' are open condenser water loops, domestic water and all pool applications.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Provide isolation valves and unions or flanges on all connections to the heat exchanger in locations to permit the disassembly without disrupting the system piping.
 - 3.1.2. Ensure both sides of the heat exchanger are isolated when either side of the exchanger is drained in order to protect unit against an excessive pressure differential from damaging the unit.
 - 3.1.3. The Contractor shall provide a lamacoid on each heat exchanger that reads as follows:
"WARNING: ISOLATE BOTH SIDES OF THE HEAT EXCHANGER WHEN DRAINING
EITHER SIDE OF THE UNIT"

END OF SECTION

23 72 19.00 Energy Recovery Ventilators

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Shop Drawings:

- .1 Submit Shop Drawings of all energy recovery ventilators with catalogued components to be supplied. Include manufacturer's data sheets for: performance criteria, ratings, and physical dimensions and finishes.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Commercial Energy Recovery Ventilators (ERV):

- .1 Provide belt driven, indoor type, horizontal and/or bottom return/discharge ERV as shown.
- .2 Manufacturer: Mitsubishi Lossnay, Loren Cook, Engineered Air, Venmar, Aldes, Greenheck, or Ruskin
- .3 Unit:
 - .1 Of bolted construction utilizing corrosion resistant fasteners.
 - .2 Walls and roof: bolted to a 16 ga. galvanized steel base with lifting lugs.
 - .3 Provided with all internal surfaces covered with 25 mm (1 in.) thick, 3 lb. density foil faced insulation. Fasten insulation with adhesive and weld pins.
 - .4 Energy recovery wheel mounted in a slide track for easy inspection and cleaning. Provide separate blower and motor for supply and exhaust airstream for independent system balancing.
 - .5 Blower and motor assemblies mounted on rubber vibration isolators.
 - .6 Provide 50 mm (2 in.) thick, 30 % efficient pleated filters for supply and exhaust airstreams.
 - .7 Provide removable side panels for easy access to motors, blowers, filters and energy recovery wheel.
 - .8 Provide unit with an engraved aluminum nameplate and ship unit in International Safe Transit Association (ISTA) certified transit tested packaging.
- .4 Provide units with:
 - .1 Energy Wheel: A total energy recovery wheel constructed of fluted synthetic fiber-based media impregnated with a non-migrating water selective 4 angstrom

- molecular sieve desiccant. Wheels with the desiccant applied in a secondary operation will not be accepted. Energy transfer ratings AHRI certified in accordance AHRI Standard 1060 "Performance Ratings of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment."
- .2 Electric Re-Heat Coil: Provide coils of the capacity shown on the Drawings. Provide all controls integral to the unit.
 - .3 Filters: Standard size 50 mm (2 in.) thick, 30 % efficient pleated filters in both supply and exhaust air streams.
 - .4 Fan Wheel: DWDI centrifugal forward curved type, constructed of painted steel. Wheel balanced in accordance with AMCA Standard 204 "Balance Quality and Vibration Levels for Fans."
 - .5 Motor: High efficiency heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure suitable for variable frequency drives where indicated.
 - .6 Controls and Electrical: All internal electrical components pre-wired for single point power connection. Internal control panel cUL listed with hinged access door and interlocking CSA Type 3R fused disconnect switch. Provide each motor complete with variable frequency drive. Provide a 24 V circuit to allow remote on/off control of ERV by Building Automation System and control each variable frequency drive via a 0-20 mA connection by the BAS. Provide short circuit protection on primary and secondary of control power transformer.
 - .7 Bearings: Permanently lubricated, sealed ball type selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.
 - .8 Belts and Drives: Provide oil and heat resistant, non-static type belts. Provide precision machined cast iron type drives, keyed and securely attached to the wheel and motor shafts. Size drives for 150% of the installed motor horsepower. Set the variable pitch motor drive to the specified fan RPM at the factory.
- .5 Provide unit complete with the following control options:
- .1 Filter Sensor – Monitors fan compartment pressure change, which actuates a filter sensor warning light on the unit controller.
 - .2 Rotation Sensor – Monitors wheel rotation. When wheel stops, sends a 24 V signal to the BAS.
 - .3 Economizer Mode – Stops wheel during periods when outdoor air conditions are close to indoor air conditions such that sensible and latent heat transfer no longer occurs.
 - .4 Remote enthalpy sensor.
 - .5 Preheat Frost Control – Provide outside air temperature sensor. When outside air is below a preset air temperature, energize a two stage electric coil to preheat intake air. Refer to schedule for electric heater kW rating.
 - .6 Motorized dampers for unit isolation on the outside air and return air.
 - .7 Backdraft damper on exhaust air discharge.

3. Execution

3.1. INSTALLATION

3.1.1. General:

- .1 Install all ventilators with vibration isolation hangers with flexible connections on both inlet and outlet.
 - .2 Provide full size access panels.
- 3.1.2. Residential Suite Heat Recovery Units:
 - .1 Install room ventilators where shown.
- 3.1.3. Commercial Energy Recovery Ventilators (ERV):
 - .1 Install as per manufacturer's written recommendations.
 - .2 Co-ordinate controls with Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM (BAS).

END OF SECTION

23 74 13.13 Small Packaged (Modular) Roof Mounted Air Conditioning Units

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings in accordance with Section 20 05 03.00 - SHOP DRAWINGS. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Packaged roof top units shall be Aaon, Daikin, Carrier, Lennox, or JCI York.

2.1.2. Units shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Cooling capacity, heating capacity and fan performance shall be ARI certified. Complete unit shall be ETL- Canada listed.

2.1.3. Provide units that are safety certified to CAN/CSA-C22.2 No. 60335-2-40 "Safety of household and similar electrical appliances - Part 2 - 40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers" for units utilizing A2L class refrigerants.

2.1.4. Unit shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be **10,000 A**. Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.

2.1.5. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of the supply and return fan assemblies, a refrigeration circuit run test, a unit control system operations checkout, test and adjustment of the gas furnace, a unit refrigerant leak test and a final unit inspection.

2.1.6. Each unit shall be complete with all components required for a complete and operational system, including but not limited to the following:

- .1 ECM variable speed supply air fan section with centrifugal fans.
- .2 Air cooled refrigeration section
- .3 Economizer fan and damper section
- .4 Roof top enclosure

- .5 Remote space 7 Day Programmable Heating/cooling thermostat with Tenant Override capability
 - .6 Filter section
 - .7 Roof mounting frame and curb
 - .8 Back up heating coil.
 - .9 Enthalpy wheel heat recovery section
- 2.1.7. Provide weatherproof rooftop enclosure for all above components, complete with an outside air inlet. Factory install piping and wiring of all components, complete with all safety and operating controls, and make ready for field connection of power and thermostat wiring to terminal strip, and gas piping to gas inlet.
- 2.1.8. Each unit shall have the capacity shown in the Roof Top Unit Schedules with 35 deg. C. (95 deg. F.) ambient air entering the condenser.
- 2.1.9. Unit shall be capable of delivering 1415.8 L/s (3000cfm) at 12.8 deg. C. (55 deg. F.) db. and 12.8 deg. C. (55 deg. F.) wb with 35 deg. C. (83.1 deg. F.) ambient air entering the condenser when in cooling mode and of delivering 1415.8 L/s (3000 cfm) at 21.1 deg. C. (70 deg. F.) with 6.7 deg. C. (44 deg. F.) entering when in heating mode.
- 2.2. CASING
- 2.2.1. Exterior panels shall be double-wall construction. Insulation shall be a minimum of 1" thick with an R-value of 4.0, and shall be neoprene coated glass fiber. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance.
- 2.2.2. The frame and unit base shall be heavy gauge galvanized steel. Unit base shall overhang the roof curb for water runoff and shall have a formed recess that seats on the roof curb gasketing to provide a positive weather tight seal
- 2.2.3. Service doors shall be provided for the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
- 2.2.4. Stainless steel drain pans shall be sloped in two directions and comply with ASHRAE Standard 62.1. The drain pan shall extend beyond the leaving side of the coil.
- 2.3. FAN SECTION
- 2.3.1. Supply air fan shall be centrifugal with capacity to deliver the air quantity shown as outlined in the Roof Top Unit Schedule. Reinforce casings to prevent drumming.
- 2.3.2. Fan assemblies shall be statically and dynamically balanced for quiet operation. Provide slide out rails for servicing and maintenance of the fan. All fan assemblies shall employ solid steel fan shafts. Bearings shall be sized to provide an L-50 life of 250,000 hours.
- 2.3.3. The fan assembly shall have adjustable pitched sheaves on the motor. Bushings shall be used on all sheaves to allow for easy removal of the pulleys from the fan and motor shaft. Fixed bore pulleys fastened to the shaft by setscrews will not be allowed. The drives shall be selected with a 1.2 service factor.
- 2.3.4. Variable air volume systems, or units serving single zones shall be provided with variable speed drives to reduce airflow at cooling loads below 50% per ASHRAE 90.1.

- 2.3.5. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. Acceptable alternate is a premium efficiency open drip proof motor suitable for use with a variable speed drive. Motor safeties shall include thermal overload protection and phase failure protection. Provide variable speed drive integral with the unit.
- 2.4. FILTER SECTION
- 1.1.1. Filter section shall be complete with Farr D/C or other approved manufacturer of 50 mm (2 in.) thick pre-filter consisting of throw away media in permanent frames. Media shall have an efficiency of (2 inch Merv 13-85%) (4 inch Merv 14-95%).
- 2.5. ECONOMIZER
- 2.5.1. Unit shall be provided with an outdoor air economizer section. The economizer shall include outdoor, return, and exhaust air dampers. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit.
- 2.5.2. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be opposed blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 4 cfm / square foot of damper area at 1" differential pressure per ASHRAE 90.1 Energy Standard.
- 2.5.3. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. If powered economiser is to be provided, delete barometric
- 2.5.4. Powered economizer shall provide free cooling using up to 100% outside air at all outside temperatures below 23.9 deg. C. (75 deg. F.) and minimum of approximately 10% outside air shall be provided above this temperature. Outside air damper shall close when unit is shut down. Include powered economiser option depending on return air path conditions Exhaust fans shall be direct drive, axial type. Blades shall be constructed with fabricated steel and shall be securely attached to fan shafts. All exhaust fan assemblies shall be statically and dynamically balanced. Motors shall be permanently lubricated, heavy-duty type, carefully matched to the fan load. Ground and polished steel fan shafts shall be mounted in permanently lubricated and sealed ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speeds.
- 2.5.5. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.
- 2.6. REFRIGERATION AND CONDENSING SECTIONS
- 2.6.1. Coils shall have seamless copper tubes, mechanically bonded to aluminum plate-type fins. The fins shall have full drawn collars to completely cover the tubes.
- 2.6.2. Air cooled refrigeration section shall provide stable operation down to 12.8 deg. C. (55 deg. F.) Only include where required, otherwise economiser will be sufficient outside air temperature.
- 2.6.3. Optional low ambient cooling to 0 degrees F shall be provided. Include only if required, otherwise delete.

- 2.6.4. Condenser fans shall be direct drive, axial type designed for low tip speed and vertical air discharge. These fans are standard arrangement. Choose this option or paragraph below to upgrade to EC. Condenser fan rpm shall be 1140 rpm maximum. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three-phase, non-reversing type with permanently lubricated ball bearing and integral rain shield.
- 2.6.5. Fan motors shall be ECM type. The rooftop controller shall proportionally control the speed. This is an option on only a few available units. Confirm requirement for Project. of the condenser fan motors to maintain the head pressure of the refrigerant circuit within acceptable limits. Mechanical cooling shall be provided to 0 deg. F. Motor safeties shall include thermal overload protection and phase failure protection.
- 2.6.6. The condenser fan shall be dynamically designed for low noise generation with low tip speeds. Fan blade shall be of a composite material. The maximum sound power level shall be xx/xx/xx/xx for the 2nd/3rd/4th/5th power bands respectively. Choose the composite/profile fan for Projects that required reduced sound power levels at the condenser.
- 2.6.7. All units of 6.5 ton capacity and above shall have minimum two independent refrigeration circuits.
- 2.6.8. Each circuit shall have fan cycling on at least one condenser fan to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 20 deg. F.
- 2.6.9. Each unit shall have multiple, heavy-duty scroll compressors. Each compressor shall be complete with gauge ports, crankcase heater, sight-glass, anti-slug protection, motor overload protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.
- 2.6.10. Variable Speed Compressors Confirm availability of this option. This is an upgrade for additional energy savings.
- .1 The unit shall have multiple scroll compressors. One of the compressors shall be inverter driven and the unit controller must control the speed of the compressor to maintain the discharge air temperature.
- 2.6.11. Each circuit shall be complete with isolation ball valves on the suction and discharge sides of the compressor, a low pressure control, filter-drier, liquid moisture indicator/sight-glass, thermostatic expansion valve, and a manual reset high pressure safety switch. The thermal expansion valve shall be capable of modulation from 100% to 25% of its rated capacity. Sight-glasses shall be accessible for viewing without disrupting unit operation.
- 2.6.12. The refrigeration circuit shall have both low and high pressure safety switches. Temperature sensors shall be provided for measuring suction and discharge temperature of the refrigerant.
- 2.6.13. Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for compressor startup under low head pressure conditions. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.
- 2.6.14. Each circuit shall be dehydrated and factory charged with Refrigerant and oil.

2.7. HEATING SECTION

- 2.7.1. Natural gas fired heating section shall provide indirect heating through an aluminized steel or stainless steel heat exchanger if the return air is greater than 30% of the outside air volume; or Type 409 stainless steel heat exchanger if the return air is less than 30% of the outside air volume. Provide electric ignition with remote flame sensor. Unit shall be suitable for 1.74 kPa (7 in.wg.) gas pressure. The natural gas section shall be capable of modulating at a 10:1 staging ratio.
- 2.7.2. Electric heating coils shall be of the open resistance element type of 80% nickel and 20% chromium. Elements shall be uniformly distributed over the cross sectional area of the unit with vertical support brackets to prevent coil element sag. Coil elements shall be insulated from metal by ceramic bushings. Provide expanded steel baffle on coil inlet for uniform airflow. Electric coils shall be provided with built-in primary automatic and secondary manual reset thermal protection devices and static pressure type airflow switch to prevent energization when airflow is inadequate. Delete electric heat if not required.
- 2.7.3. Provide electric coils with variable control achieved by a duct mounted thermostat and SCR controller. Provide control panel with a unit mounted circuit breaker size for interrupting capacity as to meet CSA requirements.
- 2.7.4. Control panels shall be integral to the heating coil (remote mounted). Control panels shall be of CSA construction with magnetic circuit fusing for each 48 amp circuit to meet CSA requirements, SCR controller and 120 volt fused control power transformer sized as required. All control and safety devices shall be factory wired as to meet CSA requirements. Thermostat provided under Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM (BAS).

2.8. HEAT RECOVERY SECTION

- 2.8.1. The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and shall not require field assembly.
- 2.8.2. Energy wheel performance shall be AHRI Standard 1060 Certified and bear the AHRI Certified Product Seal. The energy recovery media shall have a minimum of 70% effectiveness at nominal unit airflow. The energy recovery section shall be UL/ULC Recognized component for electrical and fire safety.
- 2.8.3. The wheel shall be coated with silica gel desiccant, permanently bonded without the use of binders or adhesives. Coated wheels shall be washable with detergent or alkaline coil cleaner and water. The silica gel shall not dissolve or deliquesce in the presence of water or high humidity.
- 2.8.4. The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.
- 2.8.5. Fresh air to the wheel shall be filtered by 50 mm (2 in) MERV 7 filters.
- 2.8.6. The substrate shall be made of a lightweight polymer and shall not degrade or require additional coatings for application in coastal environments. The wheel polymer layers shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop. The polymer layers shall be captured in a stainless steel wheel frame or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
- 2.8.7. Energy recovery wheels greater than 480 mm (19 in.) in diameter shall be provided with removable wheel segments.

- 2.8.8. Wheel frame shall be a welded hub, spoke and rim assembly of stainless, plated, and or coated steel and shall be self-supporting without the wheel segments in place. Wheel rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
- 2.8.9. Wheel segments shall be removable without the use of tools to facilitate maintenance and cleaning.
- 2.8.10. Wheel bearings shall provide an L-10 life of 400,000 hours.
- 2.8.11. The exhaust air fan shall be a direct drive plenum fan coupled to an ECM motor or a VFD driven motor Exhaust air fan may not be available on all unit sizes. Confirm with manufacturer. The unit controller shall control the exhaust fan to maintain building pressure.
- 2.8.12. The control of the energy recovery wheel shall be an integral part of the rooftop unit's main controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature.
- 2.8.13. The rooftop unit DDC controller shall provide frost prevention for the energy recovery wheel. Select method of wheel control and frost control The DDC controller will start and stop the energy wheel to prevent the wheel from reaching a frost condition.
- 2.8.14. Variable speed control shall be accomplished by the use of an A/C inverter. The control system shall modulate the rotational speed of the wheel based on supply air temperature. Rotational speed shall be automatically reduced to prevent frosting. Supply air temperature shall be manually adjusted via unit mounted potentiometer. The control system shall include four linearized thermistor sensors:
 - .1 Proportional temperature controller mounted in the supply air stream,
 - .2 Differential summer/winter change over sensors mounted in the outdoor and return air streams,
 - .3 Frost prevention sensor located in the exhaust air stream.
- 2.8.15. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
- 2.9. SPACE HUMIDITY CONTROL/ HOT GAS REHEAT
 - 2.9.1. The hot gas reheat humidity control option shall be factory installed and shall provide greater dehumidification of the occupied space by two modes of dehumidification operations in addition to its normal design cooling mode:
 - .1 Subcooling mode further sub cools the hot liquid refrigerant leaving the condenser coil when both temperature and humidity in the space are not satisfied.
 - .2 Hot gas reheat mode shall mix a portion of the hot gas from the discharge of the compressor with the hot liquid refrigerant leaving the condenser coil to create a two-phase heat transfer in the system, resulting in a neutral leaving air temperature when only humidity in the space is not satisfied.
 - .3 Includes head pressure controller on refrigeration circuit.
 - 2.9.2. The hot gas reheat coil shall be {single stage.} {fully modulating with control of the leaving air temperature accurate to +/- 2°}. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling and reheat leaving air temperature set points shall be adjustable through the unit controller.
 - 2.9.3. Hot gas coil shall be sized to allow for full condensing across the operation range of the unit. High temperature liquid shall be piped downstream of the unit's condenser coils into the liquid line.

- 2.9.4. The refrigeration circuit shall not require receivers. The hot gas coil shall be used for refrigerant storage when the unit is not operation in a dehumidification or reheat mode.
- 2.10. ELECTRICAL
- 2.10.1. Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with all applicable UL and CSA standards. All wiring shall be number coded per the electrical wiring diagrams. All electrical components shall be labeled according to the electrical diagram and be CSA recognized where applicable.
- 2.10.2. Unit shall be suitable for 575/3/60 or 208/3/60 power supply as scheduled. Select a suitable voltage.
- 2.10.3. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 120 volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit.
- 2.10.4. Provide mechanical screw-type lugs designed for copper conductors and sized to handle 125% of total heater load in the control panel for terminating power wiring. Provide a complete wiring diagram permanently attached to the inside of the control panel cover.
- 2.10.5. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.
- 2.10.6. A GFI receptacle shall be unit mounted. The receptacle shall be powered by a factory installed and wired 120 V, 20 amp power supply. The power supply shall be wired to the line side of the unit's main disconnect, so the receptacle is powered when the main unit disconnect is off. This option shall include a GFI receptacle, transformer, and a branch circuit disconnect.
- 2.10.7. Provide harmonic filter for Electronically Commutated Motors (ECM) or for Unit, in accordance with the requirements of Section 20 35 26.00 – HARMONIC FILTERS.
- 2.11. ROOF CURB
- 2.11.1. Provide a roof mounting frame for each unit. In addition, furnish a supplementary frame to compensate for the sloping roof This is a costly option. Only include when necessary. This supplementary frame shall mate with the unit frame and be of the same thickness.
- 2.11.2. Roof curb shall be prefabricated 14-gauge galvanized steel, mounting curb for field assembly on the roof decking. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 610 mm (24 in.) high. Gasket shall be provided for field mounting between the unit base and roof curb.
- 2.12. REFRIGERANT LEAK DETECTION SYSTEM
- 2.12.1. The system must provide all the functionalities necessary to comply with current ASHRAE 15 "Safety Standard for Refrigeration Systems" guidelines and CSA B52 "Mechanical Refrigeration Code" requirements to limit the releasable refrigerant charge consisting of the following:
- .1 Non-adjustable, refrigerant leak detector(s) located within the refrigerant coil section of the unit.
 - .2 Self-diagnostic capabilities.

- 2.12.2. Upon detection of leaked refrigerant or failure of any leak detector, the system shall de-energize electric resistance heat within the unit and/or downstream ductwork, energize air circulating fans, and isolate all possible paths of refrigerant.
- 2.13. CONTROLS
- 2.13.1. Each unit shall be equipped with a microprocessor based direct digital control (DDC) system. The unit control system shall include all required temperature and pressure sensors, input/output boards, main microprocessor and operator interface. The unit control system shall perform all unit control functions including scheduling, unit diagnostics and safeties.
- 2.13.2. The stand-alone microprocessor controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand-alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in non-volatile memory. No settings shall be lost, even during extended power shutdowns.
- 2.13.3. The microprocessor control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- 2.13.4. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
- 2.13.5. The microprocessor controller shall have a built-in adjustable time schedule. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
- 2.13.6. The unit is to be programmed with a night setback or setup function, with a signal provided from a space sensor. Sensor options shall include a zone sensor with tenant override switch plus heating and cooling set point adjustment.
- 2.13.7. Provide a seven day programmable heating/cooling thermostat with integral selection switch for each unit. Provide a key-locked tamper-proof cover for each thermostat. Delete clause for thermostat if the RTU will be connected to a BAS.
- 2.13.8. At the main micro-processor controller provide a unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
- .1 Return air temperature
 - .2 Discharge air temperature
 - .3 Outdoor air temperature
 - .4 Space air temp
 - .5 Outdoor enthalpy, high/low
 - .6 Dirty filter indication
 - .7 Airflow verification
 - .8 Cooling status
 - .9 Control temperature (Changeover)

- .10 VAV box output status
 - .11 Cooling status/capacity
 - .12 Unit status
 - .13 All time schedules
 - .14 Active alarms w/time and date
 - .15 Previous alarms with time and date
 - .1 Optimal start
 - .2 System operating hours
 - .3 Fan
 - .4 Exhaust fan
 - .5 Cooling
 - .6 Individual compressor
 - .7 Heating
 - .8 Economizer
 - .9 Tenant override
- 2.13.9. For variable air volume systems, the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:
- .1 Airflow
 - .2 Outside air temperature
 - .3 Space Temperature
 - .4 Return air temperature
 - .5 External signal of 1-5 VDC
 - .6 External signal of 0-20 mA
 - .7 Network signal
- 2.13.10. On constant volume applications, the DDC controller shall include a supply air fan speed reset sequence. The speed of the supply fan shall be modulated from high speed to low speed based on:
- .1 Status of Compressor staging
- 2.13.11. The unit control system shall have the ability to communicate to an independent Building Management System through a direct (BACnet Ethernet) (BACnet MSTP) (LonTalk) communication connection. The independent BMS system shall have access to "read only" variables and "read & write" variables. Communications shall not require field mounting of any additional sensors or devices at the unit.
- 2.14. SEQUENCE OF OPERATION
- 2.14.1. The unit shall be controlled on a time of day. The unit shall accept the programmed room temperature setpoint based on time of day, and current room temperature.
- 2.14.2. The supply air fan shall remain operational when the space is in occupied mode.
- 2.14.3. On a call for cooling, the RTU controller shall modulate both the supply air fan and the D/X cooling stages in sequence to maintain the current space temperature setpoint based on the current space conditions. When the cooling demand is less than 50%, the controller shall reduce the fan speed accordingly.

- 2.14.4. On a call for heating, the RTU shall operate the fan at 50% (programmable) speed and modulate the gas burner to maintain the current space temperature setpoint based on the current space conditions.
- 2.14.5. When the RTU is in un-occupied mode, the fan shall cycle with the D/X cooling stages and the gas burner as required to maintain the space unoccupied setpoint.

3. Execution

3.1. INSTALLATION

- 3.1.1. Provide all control wiring from thermostat and thermostat sub-base.
- 3.1.2. Supply and install wiring of the airflow switch for the electrical coil.
- 3.1.3. Provide access to all components of the refrigerant leak detection system for testing and replacement.
- 3.1.4. Gas fired roof top unit shall not be installed closer than 2 m (6 ft.) to the edge of the roof.
- 3.1.5. BAS connection to the unit provided under Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM (BAS).
- 3.1.6. Start up and test all unit functions and ensure proper operation. Factory technician to provide copy of start-up log to Owner and to demonstrate operation and maintenance to Owner.

END OF SECTION

23 77 13.00 Expansion Tanks

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Shop Drawings: Submit Shop Drawings of the tank support frames for structural review, and tank drawings, including details and catalogue cuts of any standard components being incorporated into the system.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.2. Replaceable bladder type expansion tanks shall be pre-charged replaceable bladder type equal to Calefactio Explanflex Type 'AL', Xylem Series 'B', Armstrong Type 'L', or Amtrol Extrol Series 'L' stamped 800 kPa (125 psi) operating pressure.

- .1 Tanks shall be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.
- .2 Tanks shall be all steel construction and replaceable bladder shall be heavy duty butyl rubber compound.
- .3 Tank shall include 38 mm (1-1/2 in.) threaded bottom inlet, built in air pressure gauge, air inlet connection to facilitate adjusting of pre-charge air pressure to meet actual system conditions, and 19 mm (3/4 in.) drain connection.
- .4 Tanks shall be complete with ring base, and lifting rings.
- .5 Tanks shall have capacities as indicated in the Expansion Tank Schedule.
- .6 Tanks shall have capacities as indicated on the Drawings.

2.1.3. Diaphragm type expansion tanks shall be pre-charged diaphragm type equal to Calefactio Explanflex Type 'OT', Xylem Series 'D' or Armstrong Type 'AX' stamped 800 kPa (125 psi) operating pressure.

- .1 Tanks shall be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code.
- .2 Tanks shall be all steel construction with integral heavy duty butyl rubber diaphragm.
- .3 Tanks shall be complete with lifting rings, NPT system connection, built in air pressure gauge, and air inlet connection to facilitate adjusting pre-charge pressure to meet actual system conditions.
- .4 Tanks shall be complete with saddles.
- .5 Tanks shall have capacities as indicated in the Expansion Tank Schedule.

- .6 Tanks shall have capacities as indicated on the Drawings.
- 2.1.4. Domestic water expansion tanks:
 - .1 Capacity as indicated in the Expansion Tank Schedule.
 - .2 Lead free.
 - .3 Fixed or replaceable bladder type, or diaphragm type.
 - .4 Steel tank in-line or stand type as indicated and as per the Drawings or Schedules.
 - .5 Certified to NSF/ANSI Standard 61 "Drinking Water System Components – Health Effects."
 - .6 Factory pressurized (adjustable) with permanent separation of air and water.
 - .7 Suitable for a maximum working pressure of 1034 kPa (150 psi) at 116 deg. C (240 deg. F).
 - .8 Constructed and stamped in accordance with the ASME Code Section VIII for Unfired Pressure Vessels.
 - .9 Complete with a red oxide primer finish and the following:
 - .1 A NPT stainless steel system connection sized as shown on Drawings.
 - .2 A Schrader air charging valve.
 - .3 A heavy-duty butyl rubber bladder.
 - .4 A polypropylene liner.
 - .5 A built in air pressure gauge.
 - .6 Where replaceable bladder type expansion tank is provided, a tapping for installation of a drain valve.
 - .10 Manufacturer:
 - .1 Calefactio, Armstrong, Xylem.
- 2.1.5. Water Pressure Reducing Valve: Watts, or Cash Acme, equal to Watts UB5, screwed with low lead bronze body for operating pressures up to 2070 kPa (300 psi) at 71 deg. C. (160 deg. F.).
- 2.1.6. Upstream from pressure reducing valve, provide backflow prevention in accordance with Section 22 11 13.00 - PIPES, VALVES, AND FITTINGS (PLUMBING SYSTEMS).
- 2.1.7. Downstream from pressure reducing valve, provide a pressure relief valve. All components of valves in contact with water shall be non-ferrous. Set pressure reducing valve and pressure relief valve in accordance with the system fill pressure and maximum system pressure in the Expansion Tank Schedule, respectively.
- 2.1.8. Expansion tanks used for Glycol systems shall not have a cold water make-up connection.
- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Expansion tanks shall be self-supporting and shall be placed on 100 mm housekeeping pads.
 - 3.1.2. Provide 19 mm (3/4 in.) drain line complete with valve to nearest floor drain for replaceable bladder type expansion tanks.
 - 3.1.3. Pipe pressure relief valve to nearest floor or hub drain for water systems and to glycol make-up package for glycol systems.
 - 3.1.4. Hang expansion tanks from roof structure on angle iron frame. Support tank below each saddle. Refer to Drawings for additional details.

- 3.1.5. Support expansion tank on angle iron frame welded to base plate anchored to floor with self drilling anchor bolts cross brace with angle irons.

END OF SECTION

23 81 23.00 Computer Room Air Conditioning Units

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.1.2. Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. ALTERNATIVE PRICE
 - 1.2.1. Refer to Bidding Documents for Alternative Price to substitute Schneider, Stulz, or Data Aire equipment in lieu of Base Bid Vertiv equipment specified. Alternative may be acceptable to the Owner provided all design criteria, noise control and space requirements comply or exceed requirements of Base Bid Products.
 - 1.3. SUBMITTALS
 - 1.3.1. Submit Shop Drawings in accordance with Section 20 05 03.00 - SHOP DRAWINGS. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).
 - 1.4. WARRANTY
 - 1.4.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Computer room units shall be Vertiv self-contained factory assembled unit with down discharge air flow patter. The units shall be completely pre-piped, pre-wired and ready for final connections and manufactured and in accordance with UL listings and CSA Standards.
 - 2.1.2. Provide units that are safety certified to CAN/CSA-C22.2 No. 60335-2-40 "Safety of household and similar electrical appliances - Part 2 - 40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers" for units utilizing A2L class refrigerants.
 - 2.2. FLOOR MOUNTED UNITS
 - 2.2.1. Fabricate frame for units from 3.416 mm thick (0.1345 in - 10 MSG gauge) sheet steel, and coat with a heavy corrosion inhibiting finish. Fabricate internal panels of a 1.26 mm thick (0.048 in - 18 GSG gauge) galvanized steel, coat and seal against corrosion.
 - 2.2.2. Fabricate casings from 1.26 mm thick (0.048 in - 18 GSG gauge) steel, and coat with baked enameled finish inside and out. Colour of outer surface selected by Engineer's Representative. Supporting framework shall be suitable for mounting on raised floor.

- 2.2.3. Insulate exterior panels with minimum 25 mm (1 in.) thick glass fibre insulation. Equip panels with fasteners and make removable for access to the equipment. Arrange panels to provide access to the electrical control panel and control valve compartment without interrupting the air flow.
- 2.2.4. Furnish semi hermetic type compressor with internal spring isolation and sound muffling, complete with current overload cutout, internal motor winding thermostat, high and low pressure cutouts, and timer to prevent compressor short cycling. For dual compressors, provide a sequencing switch to alternate the lead compressor. Provide each unit with independent dual refrigeration circuits. Each circuit shall include a hot glass muffler, liquid line filter dryer, refrigerant sight glass with moisture indicator, adjustable externally equalized expansion valve, and liquid line solenoid valve.
- 2.2.5. The control system shall include four step cylinder unloaders activated by solenoid valves.
- 2.2.6. Cooling coil shall be suitable for the total cooling capacity shown. Coils shall be tested for 2070 kPa (300 psig). Drain pan and drain pipe shall be installed below coils. Each refrigerant circuit shall have a separate expansion valve. For water or glycol cooled systems, install a separate valve on each circuit.
- 2.2.7. Two way or three way modulating mixing valves shall control water flow. Valve shall have an adjustable potentiometer and shall be set to open 1/3 upon call for dehumidification. Valve shall close when unit is shut down. units shall have two way valve and units three way valves.
- 2.2.8. Refrigerant circuits shall be controlled by thermal expansion. Service valves shall be installed on all discharge, suction and liquid lines.
- 2.2.9. Provide centrifugal double inlet forward curve fans, statically and dynamically balanced. Drive the fans by 1750 rpm fan motor mounted on an adjustable slide base. Provide two-belt, variable speed drive package, sized for 200 % of the fan motor horsepower.
- 2.2.10. Thermostat shall control the cooling capacity of the unit to maintain the required setpoint. Humidistat shall control the humidifier to maintain the required humidity.
- 2.2.11. Filter shall be disposable 60 % average efficiency as measured on the NBS atmospheric duct spot method.
- 2.2.12. Heaters shall be sized to suit the cooling capacity of the unit.
 - .1 Heaters shall be electric.
 - .2 Heaters shall be suitable for 34.5 kPa (5 psig) steam entering the coil.
 - .3 Heaters shall be suitable for hot water entering at 82.2 deg. C. (180 deg. F.) and leaving at 71.7 deg. C. (160 deg. F.).
- 2.2.13. The humidifier shall be of the infra-red type consisting of high intensity quartz lamps mounted above and out of the water supply. The evaporator pan shall be stainless steel and arranged to be serviceable for cleaning without disconnecting water supply lines, drain lines, or electrical connections. The complete humidifier section shall include liquid level control, emergency overflow and shall be prepped ready for final connections. The humidification system shall use bypass air to prevent over humidification of the computer room.
- 2.2.14. The humidifier shall be provided with an automatic flush control system. The flush control system shall be field adjustable to change the cycle time in accordance with local water conditions.
- 2.2.15. Provide suitably sized and valved domestic cold water from nearest source to humidifier.
- 2.2.16. Humidifier shall be replaceable steam type with ammeter, water filter, water solenoid valve, pressure regulator, timer controlled flush cycle, drain valve, steam generator cylinder, and steam probe.

- 2.2.17. Provide suitably sized and valved domestic cold water from nearest source to humidifier.
- 2.2.18. Water cooled condenser shall be shell and tube type with water regulating valves for water entering at deg. C. deg. F.) and leaving at deg. C. (deg. F.).
- 2.2.19. Glycol cooled, condenser shall be shell and tube type with matching glycol dry cooler mounted on the roof. Dry cooler shall be complete with heavy gauge baked enameled steel casing, statically and dynamically balanced fans and cooling coils sized to match the air conditioning units capacity.
- 2.2.20. Air cooled refrigerant condenser unit shall be roof mounted with heavy gauge, baked enameled finish, with statically and dynamically balanced fans and cooling coils sized to match the air conditioning units capacity.
- 2.2.21. All components shall be suitable for volt, 3 phase, 60 cycle. Power supply units shall be complete with control transformers.
- 2.2.22. The unit shall be mounted on a floor support stand of the same height as the floor. The stand shall be supplied with the unit. Coordinate installation with the Floor Supplier.
- 2.2.23. The unit shall be mounted on a floor support stand supplied and installed by the floor manufacturer. Coordinate size and loading of the floor stand.
- 2.2.24. The main power panel shall include complete branch circuit protection for every electrical component so that any one component can be isolated from the main power supply and be completely protected from primary single phasing and over-current. Supply and factory install all fuses. Access to main power panel shall be from the front of the unit without interrupting the operation of the unit.
- 2.2.25. Provide refrigerant leak detection system as follows:
- .1 The system must provide all the functionalities necessary to comply with current ASHRAE 15 "Safety Standard for Refrigeration Systems" guidelines and CSA B52 "Mechanical Refrigeration Code" requirements consisting of the following:
 - .1 Non-adjustable, refrigerant leak detector(s) located within the refrigerant coil section of the unit.
 - .2 Self-diagnostic capabilities.
 - .2 Upon detection of leaked refrigerant or failure of any leak detector, the system shall de-energize electric resistance heat within the unit and/or downstream ductwork, energize air circulating fans, and isolate all possible paths of refrigerant.
- 2.2.26. Unit shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be **10,000 A** Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.
- 2.2.27. Provide 100% solid state electronic control system, complete with start button, stop button, and monitor panel.
- 2.2.28. The monitor panel shall have the following visual indicators for cooling, dehumidification, heating stage, change filters, humidification and low water flow.
- 2.2.29. The solid state temperature and humidity control module shall have an adjustable setpoint for room conditions. The temperature and humidity controls shall have a Push to test calibration check button, and built-in visual indicators to indicate the mode of operation of the control. All controls and control sensors shall be easily accessible plug-in modules.
- 2.2.30. Unit mounted controls shall be on/off switch, test button for indicator lights, power on, humidification, humidifier failure, air flow, filter replacement, high temperature and cooling failure. In addition a water detector and alarm shall be provided in the base of the unit.

- 2.2.31. Provide additional contacts for remote alarms for power failure, power on, running condition (air flow), humidity high/low, temperature high/low and water detector. All contacts shall be normally closed, and open to alarm.
- 2.2.32. Provide additional terminal for fire shut-down of unit.
- 2.2.33. The unit shall be provided with water detection sensors mounted under the raised floor to sense the presence of water.
- 2.2.34. Provide and install a non-locking disconnect switch with each unit.
- 2.2.35. Unit shall be as shown in the Schedules.
- 2.2.36. Unit shall be model capable of the following performances.
- 2.3. SMALL FLOOR MOUNTED UNITS (5 TONS OR SMALLER)
- 2.3.1. Computer Room air conditioning unit shall be equal to the Vertiv "Challenger 3000" factory assembled unit described hereafter. It shall be specifically designed for service from the front of the unit. The system shall be designed for draw through air arrangement to ensure even air distribution to the entire face area of the coil.
- 2.3.2. Each system shall be capable of handling 1320 L/s at 0.075 kPa (2,800 cfm at 0.3 in.) of water external static pressure with down discharge air flow pattern. It shall have a total cooling capacity of W/hr (btu/hr) sensible cooling capacity of W/hr (btu/hr), based on the entering air condition of 22.2 deg. C. (72 deg. F.) dry bulb, and 15.6 deg. C. (60 deg. F.) wet bulb. The humidifier shall have a capacity of kg/hr (lbs.hr). Reheat shall have a capacity of W/hr (btu/hr). The main fan motor shall be 1120 W (1.5 hp).
- 2.3.3. The frame shall be constructed of heliarc welded tubular and formed steel. All frame and internal fill components shall be coated using an auto deposition process to protect against corrosion. The exterior panels shall be powder coated with standard colour paint. The panels shall be insulated with a minimum 25.4 mm (1 in.), 0.68 kg (1-1/2 lbs (density fibre insulation. Front and side panels shall have captive, ¼ turn fasteners. The cabinet shall be designed so that all components are serviceable and removable from the front of the unit.
- 2.3.4. The fan shall be the centrifugal type, double width, double inlet. The shaft shall be heavy duty steel with self-aligning ball bearings with minimum life span of 100,000 hours. The fan motor shall operate at 1750 rpm and mounted on an adjustable base. The drive package shall be sized for 200% of the fan motor horsepower, and equipped with an adjustable motor pulley. The fan/motor assembly shall be mounted on vibration isolators. The fan shall be located to draw air over the coil to ensure even air distribution and maximum coil performance.
- 2.3.5. The filter shall be 50 mm (2 in.) thick and rated not less than 120% efficiency base on ASHRAE 52.2 "Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size".
- 2.3.6. For units utilizing A2L class refrigerants, provide refrigerant leak detection system as follows:
- .1 The system must provide all the functionalities necessary to comply with current ASHRAE 15 "Safety Standard for Refrigeration Systems" guidelines and CSA B52 "Mechanical Refrigeration Code" requirements consisting of the following:
 - .1 Non-adjustable, refrigerant leak detector(s) located within the refrigerant coil section of the unit.
 - .2 Self-diagnostic capabilities.
 - .2 Upon detection of leaked refrigerant or failure of any leak detector, the system shall de-energize electric resistance heat within the unit and/or downstream ductwork, energize air circulating fans, and isolate all possible paths of refrigerant.

- 2.3.7. The control system shall be microprocessor based. The system shall be provided with two 11 mm (0.43 in.) high, seven segment LED numerical display to allow observation of room temperature and humidity and each settable function.
- .1 Monitoring
 - .1 Normal Operating Modes (Heating, Cooling, Humidification, Dehumidification) shall be indicated by coloured LED's on the unit-mounted display panel.
 - .2 Control Parameters
 - .1 Temperature setpoint 18 to 29 deg. C. (65 to 85 deg. F.)
 - .2 Temperature sensitivity 1 to 3 deg. C. (1 to 5 deg. F.)
 - .3 Humidity setpoint 20-80% Rh
 - .4 Humidity sensitivity 1 to 10% Rh
 - .5 Humidifier flush rate
 - .6 Unit controls
 - .3 Compressor Short-Cycle Control
 - .1 The control system shall prevent compressor short-cycling by a 3 minute timer from compressor stop to the next start.
 - .4 Common Alarm or Remote On/off
 - .1 A common alarm relay shall be provided to interface alarms with a remote alarm device. This same relay may be used as a remote on/off control contact, instead of the common alarm function.
 - .5 Alarms
 - .1 The control system shall monitor unit operation and activate an audible and visual alarm in the event of the following factory preset alarm conditions:
 - .1 High temperature
 - .2 Low temperature
 - .3 High humidity
 - .4 Low humidity
 - .5 High head pressure
 - .6 Change filter
 - .7 Loss of air
 - .8 Local alarm
 - .6 Communications
 - .1 The microprocessor shall be compatible with all Vertiv remote monitoring and control devices.
- 2.3.8. Humidifier shall be replaceable steam type with ammeter, water filter, water solenoid valve, pressure regulator, timer controlled flush cycle, drain valve, steam generator cylinder, and steam probe.
- 2.3.9. Provide suitably sized and valved domestic cold water from nearest source to humidifier.
- 2.3.10. The low-watt density, stainless steel, finned-tubular electric reheat coils shall be capable of maintaining room dry bulb conditions when the system is calling for dehumidification. The reheat section shall include UL approved safety switches to protect the system from overheating. The capacity of the reheat coils shall be ... W/hr (56,200 btu/hr) with input power of 15 kW, controlled in 2 stages.

- 2.3.11. Construct floorstand of a heliarc welded tubular steel frame coated using an autodeposition process to protect against corrosion. Provide floorstand with adjustable legs and vibration isolation pads, mounted 300 mm (12 in.) above floor.
- 2.3.12. Mount a non-automatic molded case circuit breaker in the high voltage section of the electrical panel and with the switch accessible with the door in a closed position.
- 2.3.13. The evaporator coil shall have 0.62 sq.m. (6.67 sq.ft.) face area, 4 rows deep. It shall be configured as a frame and be constructed of copper tubes and aluminum fins and have a maximum face velocity of 123.4 m/s (405 ft/m) at 1320 L/s (2800 cfm). The coil shall be provided with a stainless steel drain pan.
- 2.3.14. The refrigeration system shall consist of a high efficiency scroll compressor, hot gas bypass, pressure safety switches, externally equalized expansion valve, filter dryer, and a refrigerant sight glass and moisture indicator.
- 2.3.15. A liquid line solenoid valve shall be provided for pump down control.
- 2.3.16. A crankcase heater shall be provided for additional system protection from refrigerant migration during off cycles.
- 2.3.17. The Vertiv manufactured air cooled condenser shall be the low profile, slow speed, direct-drive, propeller-fan type. The condenser shall be constructed of aluminum and contain a copper tube, aluminum fin coil with an integral electric control panel. The system shall be designed for 35 deg. C. (95 deg. F.) ambient.
- 2.3.18. The winter control system for the air cooled condenser shall be Vertiv Fan Speed Control (FCS). The variable speed motor shall turn on at 10% of the supply voltage and modulate in response to head pressure to a full speed of 1050 rpm. It shall be designed with ball bearings, permanent lubrication, and internal overload protection.
- 2.3.19. The control system shall be complete with transducers, thermostats and electrical control circuits, factory pre-wired and tested in an integral control panel. The transducer shall automatically sense the head pressure of the compressor and control the variable speed fan on the air cooled condenser to properly maintain the head pressure. The fan speed control system shall provide positive start-up and operation in ambient temperature as low as -28.9 deg. C. (-20 deg. F.). Included with the fan speed control system shall be a solid state winter start kit as an integral feature of the electronic control panel.
- 2.3.20. These units shall operate on 575/3/60.
- 2.4. CEILING MOUNTED UNITS
- 2.4.1. Unit shall be a ceiling mounted packaged environmental unit for spot-cooling. Configuration to be horizontal for ceiling mounting and sized to fit the 600 mm x 1200 mm (24 in. x 48 in.) opening of a standard T-bar ceiling. Capacity and electrical power requirements shall be as called for in the Schedule.
- 2.4.2. Service access to be through hinged filter and grille frame at the bottom of the unit. Fan shall be direct drive and dynamically balanced. Filters shall be disposable, 25 mm (1 in.) thick, 500 mm x 500 mm (20 in. x 20 in.) and shall be accessible through a hinged return air grille. Cabinet shall be zinc coated steel, with primer coat and baked enamel finish and internally insulated with 12 mm (1/2 in.) glass fibre insulation. Vibration isolators shall be an integral part of the cabinet.
- 2.4.3. Refrigeration system is to be completely pre-piped using Type L copper and shall include expansion valve with external equalizer, filter-dehydrator, and access fittings on the suction and liquid line. The hermetic compressor shall be provided with vibration mounting springs, line break internal protection system, forced feed lubrication and internal pressure relief valve. The evaporator coil shall have multiple circuits with seamless copper tubes and mechanically bonded aluminum fins.

- 2.4.4. Prewire electrical components including all contactors, relay control transformers, and capacitors, and mount within the hermetic cooling section. Provide terminal blocks for both control and power connections. Install Liqui-Tect sensing device at the evaporator drain pan to stop unit from operating prior to an overflow condition.
- 2.4.5. Provide 100% solid state control system employing no moving parts. Supply temperature and humidity control and stop-run switch for wall mounting.
- 2.4.6. The unit shall include reheat elements and humidifier. Removal of the humidifier for periodic cleaning and replacement shall not require any special tools, or rewiring.
- 2.4.7. The electrical controls shall be prewired. Electrical components include all required solenoid valves, contactors and safeties. Controls include solid-state humidity, temperature and stop/run switches.
- 2.4.8. Water cooled condenser shall be for counter-flow performance. The condenser shall be built into the hermetic refrigeration module complete with an adjustable water regulating valve.
- 2.4.9. Provide condensate pump.
- 2.4.10. Provide a remote mounted thermostat, located where shown and/or directed. Thermostat shall be fully adjustable for both temperature and humidity and shall be complete with on/off switch for unit.

3. Execution

3.1. INSTALLATION

- 3.1.1. Connect chilled water, domestic water, and drain piping complete with isolating valves.
- 3.1.2. Mount water detection sensors and wire to computer room units.
- 3.1.3. Provide suitably sized and valved domestic cold water from nearest source to humidifier.
- 3.1.4. Provide piping from condensate pump to nearest suitable drain.
- 3.1.5. Furnish a non-locking disconnect switch with each unit. Provide all power and control wiring required for the unit from this point.
- 3.1.6. Adjust fan drives to obtain specified air flow with allowed pressure drop for dirty filters.
- 3.1.7. Provide factory trained and authorized personnel for field start-up. Submit start up report.
- 3.1.8. Mount unit on floor stand.
- 3.1.9. Connect refrigerant system, purge and charge as required.
- 3.1.10. Provide access to all components of the refrigerant leak detection system for testing and replacement.
- 3.1.11. Field check operations of all controls on the units.

END OF SECTION

23 81 26.00 Unitary Air Conditioning Units

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings in accordance with Section 20 05 03.00 - SHOP DRAWINGS. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Provide unitary Air Conditioning Units (UACU) from the following companies, equal to Mitsubishi "Mr. Slim".

.1 Mitsubishi

.2 Daikin

.3 Carrier

.4 LG

2.1.2. Provide units that are safety certified to CAN/CSA-C22.2 No. 60335-2-40 "Safety of household and similar electrical appliances - Part 2 - 40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers" for units utilizing A2L class refrigerants.

2.1.3. Provide split system type UACU with minimum two speed indoor evaporator section and remote outdoor compressor/condensing unit.

2.1.4. Model arrangements shall be as shown, and specified in the Schedules.

2.1.5. The pipe system and components shall conform to Section 23 23 01.00 - REFRIGERANT PIPING.

2.1.6. The combination of the evaporator and condensing sections shall be provided with the capacities designated in Schedules.

2.1.7. Provide unit capable of cooling mode operation in ambient temperatures down to minus 34.4 deg. C. (30 deg. F.).

2.1.8. Provide unit with room thermostat. Dampers for right angle branch duct take-off from vertical riser shall be Air Vector, Vectrol, or other approved manufacturer.

2.1.9. Provide unit with filter.

- 2.1.10. For units utilizing A2L class refrigerants, provide refrigerant leak detection system as follows:
- .1 The system must provide all the functionalities necessary to comply with current ASHRAE 15 "Safety Standard for Refrigeration Systems" guidelines and CSA B52 "Mechanical Refrigeration Code" requirements consisting of the following:
 - .1 Safety shut off valve(s) certified in accordance with CSA C22.2 No. 60335-2-40 or No. 60335-2-89 "Household and similar electrical appliances - Safety - Part 2-89: Particular requirements for commercial refrigerating appliances and ice-makers with an incorporated or remote refrigerant unit or motor-compressor."
 - .2 Non-adjustable, refrigerant leak detector(s) located within each indoor evaporator unit.
 - .3 Self-diagnostic capabilities.
 - .2 Upon detection of leaked refrigerant or failure of any safety shut off valve or leak detector, the system shall de-energize electric resistance heat within the system, activate the release mitigation controls, energize air circulating fans, and isolate all possible paths of refrigerant.
 - .3 Upon loss of power to any portion of the refrigerant release mitigation controls, the safety shut off valve(s) shall close.
- 2.1.11. Provide BACnet interface to the BAS system for monitoring and alarm purposes. At a minimum provide the following information to the BAS.
- .1 Room temperature and set point
 - .2 System Start / Stop
 - .3 Alarm conditions.
 - .4 Refrigerant leak detection system alarm
- 2.1.12. Unit shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be **10,000 A** Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install complete refrigeration and controls in accordance with the manufacturer's recommendations.
- 3.1.2. Provide access to all components of the refrigerant leak detection system and release mitigation control system for testing and replacement.
- 3.1.3. Provide interconnecting wiring between components of refrigerant release mitigation controls.
- 3.1.4. Roof mounted condensers shall be complete with feet and secured to 750 mm x 750 mm (30 in. x 30 in.) precast concrete paving slabs.

END OF SECTION

23 81 29.00 Variable Refrigerant Flow (VRF) Systems

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings in accordance with Section 20 05 03.00 - SHOP DRAWINGS. Ensure Shop Drawings include unit Short Circuit Current Rating (SCCR).

1.2.2. Provide full system schematics complete with refrigerant pipe sizing, length of piping between components, wiring and control details.

- .1 Have Professional Engineer registered in the place of the Project stamp and sign the submittal.
- .2 Identify maximum refrigerant capacity including maximum trim charge.
- .3 Identify refrigerant pipe length take offs for each portion of the schematic and the maximum allowable length for the given portion.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. The units shall be listed by Electrical Laboratories (ETL) and bear the cETL label.

2.1.2. Provide units that are safety certified to CAN/CSA-C22.2 No. 60335-2-40 "Safety of household and similar electrical appliances - Part 2 - 40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers" for units utilizing A2L class refrigerants.

2.1.3. All wiring shall be in accordance with the Electric Code.

2.1.4. All units shall meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems.

2.1.5. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.

2.1.6. Provide systems from:

- .1 Daikin
- .2 LG
- .3 Panasonic
- .4 Mitsubishi

- 2.1.7. The variable capacity air conditioning system shall consist of multiple indoor evaporator units, refrigerant joints and headers, a 2 or 3 pipe refrigeration distribution system using microprocessor control, and outdoor unit. The outdoor unit shall be a direct expansion (DX), air-cooled heat pump, multi-zone air-conditioning system with variable speed driven compressors using refrigerant.
- 2.1.8. The pipe system and components shall conform to Section 23 23 01.00 - REFRIGERANT PIPING.
- 2.1.9. The system shall be installed by the Manufacturer's Factory Trained Contractor. Provide proof of training and certification upon request.

2.2. INDOOR EVAPORATOR UNITS

- 2.2.1. Microprocessor control shall be used to control superheat to satisfy a room temperature set point. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature when used with matching remote control.
- 2.2.2. Indoor units shall be designed for refrigerant, completely factory assembled and tested. Internal unit components shall be factory wired and piped and complete with electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-re-start function, 3-minutes fused time delay and test run switch.
- 2.2.3. All unit refrigerant pipes shall be charged with dehydrated air or nitrogen prior to shipment from the factory.
- 2.2.4. Coils shall be of the direct expansion (DX) type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
- 2.2.5. Ducted indoor units shall be designed for ceiling concealed installation and shall be supplied with a horizontal discharge air connection, return air plenum and inlet air connection. Cabinet shall be constructed with sound absorbing fibre free insulation.
- 2.2.6. Ductless indoor units shall be designed for exposed installation and shall be white. Discharge air direction shall be controllable.
- 2.2.7. Standard filter shall be mold resistant, washable.
- 2.2.8. The fan shall be a direct-drive fan, with a statically and dynamically balanced impeller, with high/low or variable speed fan operation.

2.3. OUTDOOR CONDENSING UNITS

- 2.3.1. The outdoor condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit and the condensing unit shall consist of variable speed scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filter, shut-off valves, oil separators, service ports and refrigerant regulator.
- 2.3.2. The outdoor unit shall be completely weatherproof and corrosion resistant, constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- 2.3.3. The system shall automatically restart after a power failure, which shall not cause the programming or any settings to be lost.
- 2.3.4. The following safety devices shall be included on the condensing unit;
 - .1 high pressure switch,
 - .2 control circuit fuses,
 - .3 crankcase heaters,

- .4 fusible plug,
 - .5 high pressure switch,
 - .6 overload relay,
 - .7 inverter overload protector,
 - .8 thermal protectors for compressor and fan motors,
 - .9 over current protection for the inverter and
 - .10 anti-recycling timers.
- 2.3.5. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature.
- 2.3.6. The condensing unit fan shall have multiple or variable speed operation.
- 2.3.7. The fan motor shall have permanently lubricated bearings.
- 2.3.8. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
- 2.3.9. The condensing unit coil shall be manufactured from seamless rifled bore copper tubes mechanically expanded into waffle louver aluminum fins to form a mechanical bond.
- 2.3.10. The fins shall be corrosion resistant.
- 2.3.11. The inverter scroll compressors shall be variable speed controlled capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
- 2.3.12. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll type. Compressor shall be internally isolated.
- 2.3.13. Compressor capacity shall modulate automatically to maintain a constant suction pressure while varying the refrigerant volume for the needs of the cooling or heating loads.
- 2.3.14. Compressors shall have a low torque start.
- 2.3.15. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector. Oil separators shall be standard with the equipment together with an intelligent oil management system. Oil recovery cycle shall be automatic.
- 2.4. REFRIGERANT LEAK DETECTION SYSTEM
- 2.4.1. The system must provide all the functionalities necessary to comply with current ASHRAE 15 "Safety Standard for Refrigeration Systems" guidelines and CSA B52 "Mechanical Refrigeration Code" requirements consisting of the following:
- .1 Safety shut off valve(s) certified in accordance with CSA C22.2 No. 60335-2-40 or No. 60335-2-89 "Household and similar electrical appliances - Safety - Part 2-89: Particular requirements for commercial refrigerating appliances and ice-makers with an incorporated or remote refrigerant unit or motor-compressor."
 - .2 Non-adjustable, refrigerant leak detector(s) located within each indoor evaporator unit.
 - .3 Self-diagnostic capabilities.
- 2.4.2. Upon detection of leaked refrigerant or failure of any safety shut off valve or leak detector, the system shall de-energize electric resistance heat within the system, activate the release mitigation controls, energize air circulating fans, and isolate all possible paths of refrigerant.
- 2.4.3. Upon loss of power to any portion of the refrigerant release mitigation controls the safety shut off valve(s) shall close.

2.5. CONTROLS

- 2.5.1. Indoor evaporator units shall be supplied with individual zone controllers.
- 2.5.2. Units shall bear a minimum Short Circuit Current Rating (SCCR) listed by a Nationally Recognized Testing Lab, acceptable to the local Authority Having Jurisdiction, and shall be **10,000 A** Lower SCCR listed units implying the use of current limiting fuses ahead of them in the field, in lieu of an actual appropriate SCCR rating, are not acceptable.
- 2.5.3. Each controller shall have:
 - .1 A maximum wiring length of 50 meters (164 ft).
 - .2 A self-diagnosis function that continuously monitors the system for malfunctions.
 - .3 Immediate display of fault location and condition.
 - .4 A thermostat sensor
 - .5 Ability to monitor room temperature and preset temperature by microcomputer and select cool/heat operation mode automatically (Heat Recovery Units only).
 - .6 A 48 hour clock / calendar backup.
 - .7 A built-in schedule timer.
- 2.5.4. Provide BACnet interface to the BAS system for monitoring and alarm purposes. At a minimum provide the following information to the BAS.
 - .1 Room temperature and set point
 - .2 Compressor status
 - .3 System Start / Stop
 - .4 Remote reset
 - .5 Alarm conditions.
 - .6 Refrigerant leak detection system alarm

3. Execution

3.1. INSTALLATION

- 3.1.1. Refrigeration pipe system shall be in accordance with Section 23 23 01.00 - REFRIGERANT PIPING.
- 3.1.2. Install complete refrigeration system, controls, and control wiring in accordance with the manufacturer's recommendations. Zone controllers shall be wired by installing Contractor.
- 3.1.3. Provide access to all components of the refrigerant leak detection system and release mitigation control system for testing and replacement.
- 3.1.4. Provide interconnecting wiring between components of refrigerant release mitigation controls.
- 3.1.5. Outdoor condensing units shall be secured on a stand or concrete pavers as per manufacturer's requirements. Install units on a flat surface level within 3 mm (1/8 in). Condensing units shall be installed above the snow line. Provide manufacturer supplied condensing unit frames as required.
- 3.1.6. Provide certified wiring schematics to the Electrical Division for associated equipment and controls.
- 3.1.7. Insulate all refrigeration pipe in accordance with Section 20 07 00.00 - INSULATION.
- 3.1.8. Provide an authorized technician to commission the installation and provide training for the operators.

3.2. COMMISSIONING

- 3.2.1. Supplier to provide commissioning (Cx) and warranty the system including validation of pipe length, size, and trim charge. Provide copy of Cx report and confirmation of final trim charge within acceptable design range for maximum refrigerant concentrations.
- 3.2.2. Provide supplier's Cx report within the O&M manual. Ensure that VRF trim charge is included in report.

END OF SECTION

23 82 16.00 Coils

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Provide low Global Warming Potential (GWP) refrigerant complying with the performance requirements stated within Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Coils: Daikin, Heatcraft, Engineered Air, Aerofin, JCI York or Greenheck, LJ Wing.

2.1.2. All coils shall have certified AHRI capacities.

2.1.3. All coils shall be of copper tube, aluminum fin construction with minimum 1.26 mm thick (0.048 in - 18 GSG gauge) galvanized sheet steel casing and galvanized steel angles for heating coils and 1.56 mm thick (0.0625 in - 16 USG gauge) Type 304L stainless steel casing and stainless steel angles for cooling coils. Header shall be copper tube or cast iron.

- .1 Coils for mounting in ductwork shall have holes in frame for bolting to flanged ductwork.
- .2 Cooling coils shall have fins spaced not closer than 3.175 mm OC (8 to the in.).
- .3 Water coils shall have serpentine circuiting arranged for counter flow between the air and water.
- .4 Coils shall be suitable for 860 kPa (125 psig) water pressure for low pressure systems and suitable for 1720 kPa (250 psi) water pressure for high pressure systems.
- .5 Coils shall be complete with plugged drain and vent connection, readily accessible.
- .6 Face velocity shall not exceed 3.81 m/s (750 fpm) for heating coils and 2.54 m/s (500 fpm) for cooling coils.
- .7 Provide dielectric couplings to ensure galvanic action does not occur between dissimilar metals.

2.1.4. Refrigerant coils shall provide cooling by the direct expansion of refrigerant inside the tubes. The refrigerant shall be distributed to the various coil circuits through a venturi type distributor having a low pressure drop and arranged for down-feed having male sweat connection. A maximum of 12 refrigerant circuits shall be supplied from a single distributor.

- .1 Provide two distributors when more than 12 circuits are required. The refrigerant shall be distributed from the multi-outlet distributor to the coil circuits through round seamless copper tubes, 8 mm OD or 6 mm OD (5/16 in. OD or 1/4 in. OD).

- .2 Refrigerant coils shall be tested at 2070 kPa (300 psi) air pressure under water, cleaned, dehydrated and sealed with a dry nitrogen charge. Coil shall be suitable for working pressures up to 125 kPa (250 psi).
- .3 Where indicated on Drawings, refrigeration coils shall be horizontally split to match the refrigerant system.
- 2.1.5. Provide cooling coils in accordance with the Cooling Coil Schedule. All air pressure drops shall be based on wet coils.
- 2.1.6. Provide heating coils in accordance with the Heating Coil Schedule.
- 2.1.7. Provide all coils with a maximum dry-coil pressure drop of 187 Pa (0.75 in. wg.) at 2.54 m/s (500 fpm).
- 2.1.8. Drain pans below each cooling coil shall be fabricated from minimum 0.9525 mm thick (0.0375 in - 20 USS gauge) Type 304L stainless steel sheet and formed stainless steel angles, and shall extend full length of coil, double sloped at a minimum of 2% to prevent standing water with pan projecting beyond the coil. Projections shall be 75 mm (3 in.) on the air inlet side and 300 mm (12 in.) on the air leaving side of the coil. Drain pans shall be welded construction with 50 mm (2 in.) diameter stainless steel nipple for drain connection.
- 2.1.9. Cooling coil support racks shall be Type 304L stainless steel.
- 2.1.10. Coils for installation with vertical airflow shall be suitable for this orientation. Cooling coils in the vertical airflow orientation to be A-frame and/or suitably angled to prevent condensate bypassing the drain pan.
- 3. Execution
- 3.1. INSTALLATION
- 3.1.1. Coils shall be pitched and installed as required in the manufacturer's installation instructions. The lowest cooling coil shall be at least 150 mm (6 in.) above the floor of the unit so that it does not sit in water.
- 3.1.2. Install blank-off panels between coils and plenums to ensure no air by-pass occurs.
- 3.1.3. Install stainless steel drain pan below each cooling coil.

END OF SECTION

23 82 33.00 Convactor Radiators

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Shop Drawings: Submit Shop Drawings of convactor radiators, including unit capacities, sizes, piping, connections, and construction details. Shop Drawing shall clearly show the amount of expansion on each section, and method of control.

1.2.2. Mock-up: Install in one 900 mm (3 ft, 0 in.) length of convactor radiator unit with enclosures, piping, valves, and other incidentals completely piped up for Engineer's Representative's review.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Radiators shown as Type 'A' shall be RENTAL model , Sterling model , or Rattling model .

2.1.2. Radiators shall have capacity shown when supplied with water entering at 71.1 deg. C. (160 deg. F.) leaving at 60 deg. C. (140 deg. F.) and with air entering at 21.1 deg. C. (70 deg. F.).

2.1.3. Provide steel double panel radiators of the lengths and in locations as indicated, and of capacities and lengths as shown on the Drawings.

2.1.4. The double heating panel radiation shall be of one-piece all-welded steel construction, consisting of a pair of flattened water tube panels welded to headers at each end. Welded to the inside of each panel shall be steel corrugated fins to increase the convective output of the radiator. The fins shall start at no less than 75 mm (3 in.) from the end of the radiator, and shall have no less than 32 fins per foot. The radiators shall include an integral heavy gauge (2.28 mm = 0.09 in. minimum) all-welded perforated top grille, which will cover the top of all of the finned areas.

2.1.5. The headers shall include all necessary inlet, outlet and vent connections as required. Standard connection sizes are 12 mm (½ in.) NPT tapered thread for supply and return piping, and 3.175 mm (1/8 in.) for the vent connection. Internal baffling is provided where required for proper water flow.

2.1.6. The panel radiation shall be capable of being mounted to typical stud wall construction without additional blocking or strapping. Appropriate wall mounting brackets shall be provided with the radiation.

2.1.7. Provide pressure ratings for the radiation as follows: MEDIUM working pressure of maximum 586 kPa (85 psig) and maximum test pressure of 758 kPa (110 psig).

- 2.1.8. Panel radiation expansion shall not exceed 1/64 inch per foot of radiation at 215 deg. F. The installer shall provide adequate expansion compensation for each radiator.
- 2.1.9. Panel radiation shall be cleaned and phosphatized in preparation for the powder coat finish. The radiation is then finish painted with a gloss powder coat finish, for a total paint thickness of 2-3 mils (0.002 in. - 0.003 in.). The color shall be "Runtal White".
- 2.1.10. Ribbed pipe cover trims, finished to match the radiators shall be provided with the radiation.
- 2.1.11. Runtal-Flex connectors shall be used where appropriate to provide expansion compensation for the radiators.
- 2.1.12. Type B convactor radiators shall be Dunham-Bush, Engineered Air, Sigma, Rittling, or Sterling.
- 2.1.13. Convactor radiators shall be complete with:
 - .1 Convactor elements consisting of copper tubes, aluminum fins and steel or cast iron headers, suitable for 1035 kPa (150 psi) working pressure.
 - .2 Steel supports for element.
 - .3 Plenum case shown painted matt black complete with supply air grille steel covering convactor element, valves and fittings and complete with access doors or openings to valves.
 - .4 Keeney type manually operated air vents with 6 mm (1/4 in.) O.D. copper tubing connected to air chamber, accessible without removing enclosure and mounted on end panel or on front panel of recessed convactor radiator.
- 2.1.14. Convactor radiators shall be sizes shown on Drawings.
- 2.1.15. Convactor radiators shall be code rated for the capacity shown when supplied with water entering at 82.2 deg. C. (180 deg. F.) leaving at 71.1 deg. C. (160 deg. F.) and with air entering at 18.3 deg. C. (65 deg. F.).

3. Execution

3.1. NOT USED

END OF SECTION

23 82 39.00 Unit Heaters

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings in accordance with Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Unit Heaters shall be Dunham-Bush, Engineered Air, Trane, Sigma, Rittling, or Sterling for horizontal or downward air discharge as shown.

2.1.2. Provide each unit heater complete with:

- .1 Direct driven propeller fan and motor.
- .2 Heating coil with copper tubes and aluminum fins
- .3 Adjustable air outlet diffuser or adjustable louver cone diffuser.
- .4 Enamel finish prime coated.
- .5 Manual starter on unit

2.1.3. Programmable wall thermostat with range 4.4 deg. C. to 26.7 deg. C. (40 deg. F. to 80 deg. F.). Thermostat shall cycle fan and valve in sequence .

2.1.4. Space temperature sensor and controls are specified under Section 23 09 00.00 BUILDING AUTOMATION SYSTEM (BAS) OPEN SYSTEM.

2.1.5. Unit heaters shall have capacities as shown in the Unit Heater Schedule.

3. Execution

3.1. INSTALLATION

3.1.1. Install in accordance with manufacturer's current installation guidelines.

END OF SECTION

23 82 39.13 Cabinet Heaters

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Cabinet Heaters shall be Dunham-Bush, Engineered Air, Trane, Sigma, Rittling, or Sterling.

2.1.2. Cabinets shall be of type shown and shall be not less than 1.5189 mm thick (0.0598 in. - 16 MSG) steel, prime coated. Provide access to the control specified below with an access panel beside discharge grille.

2.1.3. Unit shall not vibrate or rattle at any speed.

2.1.4. For floor and wall mounted units, temperature controllers shall be Honeywell, Powers, Johnson, Penn or White Rodgers with bulb firmly clamped in bulb holder in return air stream. For ceiling mounted units provide a wall thermostat with range, 5 to 25 deg. C. (41 to 77 deg. F.). Temperature controller shall cycle fan.

2.1.5. Temperature sensor and controls are specified under Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM.

2.1.6. Permanent type filters of cleanable aluminum shall be concealed from sight.

2.1.7. Cabinet heaters shall have capacities as shown (on Drawings) in the Cabinet Heater Schedule when supplied with water entering at 82.2 deg. C. (180 deg. F.) and leaving at 65.6 deg. C. (150 deg. F.) and with air entering at 15.6 deg. C. (60 deg. F.).

2.1.8. Provide electronically commutated motor (ECM) type motors.

3. Execution

3.1. INSTALLATION

3.1.1. Install a two-speed fan switch and manual starter inside of wall and floor units. For ceiling mounted units install switch on wall adjacent to unit and install starter on unit. Provide all interconnecting wiring.

3.1.2. Install in accordance with manufacturer's current installation guidelines.

3.1.3. Install remote bulb temperature controller inside of wall and floor units. For ceiling mounted units install temperature controller on wall adjacent to unit. Provide all interconnecting wiring.

END OF SECTION

23 82 39.14 Electric Cabinet Heaters

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Provide Electric Cabinet Heaters:

- .1 Steel, prime coated casing with minimum thickness of 1.27 mm (0.05 in. – 18 GA).
- .2 Tubular finned heating element.
- .3 Provide access to the control specified below with an access panel beside discharge grille.
- .4 Internal vibration isolation and construction quality to prevent vibration or rattling at any speed
- .5 High-limit temperature control with automatic reset.
- .6 Fan delay to purge residual heat.
- .7 Acceptable manufacturers are Ouellet, Reznor, or Indeeco.

2.1.2. For floor and wall mounted units, provide temperature controllers with bulb firmly clamped in bulb holder in return air stream. For ceiling mounted units, provide a wall thermostat with range, 5 to 25 deg. C. (41 to 77 deg. F.). Program temperature controller to cycle fan and heating element. Acceptable manufacturers are Honeywell, Powers, Johnson, Penn or White Rodgers.

2.1.3. Conceal all permanent type filters of cleanable aluminum from sight.

2.1.4. Provide Electric Cabinet heaters with sizes, capacities and other design parameters shown on Drawings or in schedules. Provide model suitable for installation type (exposed, recessed) noted.

2.1.5. Provide Electric Cabinet heaters with a single point 208/1/60 electrical connection that powers all components including but not limited to

- .1 Fan motor
- .2 Control panel
- .3 Safeties

2.1.6. Provide electronically commutated motor (ECM) type motors.

3. Execution

3.1. INSTALLATION

3.1.1. Install a two-speed fan switch and manual starter inside of wall and floor units. For ceiling mounted units install switch on wall adjacent to unit and install starter on unit. Provide all interconnecting wiring.

3.1.2. Install in accordance with manufacturer's current installation guidelines.

3.1.3. Install remote bulb temperature controller inside of wall and floor units. For ceiling mounted units install temperature controller on wall adjacent to unit. Provide all interconnecting wiring.

END OF SECTION

23 82 39.19 Electric Wall / Ceiling Heaters

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2. Conform to Section 26 05 01.00 - GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Commercial Electric Wall Heater

.1 Acceptable Products:

.1 Indeeco WCI Series

.2 Ouellet OAC Series

.3 Reznor EHC Series

.4 Stelpro WF

.2 Construction:

.1 18 gauge steel grille

.2 Polyester powder coat finish. Coordinate colour with Architect and Owner.

.3 Recessed mount / surface mount.

.4 Element: tubular steel finned elements.

.5 Fan Motor: permanently lubricated totally enclosed motor. Each fan capable of 160 cfm at 55 dB(A).

.6 Remote control package with 24 V relay and transformer. Capable of being controlled and monitored by the BAS system.

.7 Fan on / off switch

.8 Disconnect switch

.3 Performance:

.1 As shown in the equipment schedules.

2.1.2. Architectural Electrical Wall Heater

.1 Acceptable Products:

- .1 Indeeco WAI Series
 - .2 Ouellet OAWH Series
 - .3 Reznor EHA
 - .4 Stelpro WFA
 - .2 Construction:
 - .1 Extruded aluminum grille
 - .2 Polyester powder coat finish. Coordinate colour with Architect and Owner.
 - .3 Recessed mount / surface mount.
 - .4 Element: tubular steel finned elements.
 - .5 Fan Motor: permanently lubricated totally enclosed motor. Each fan capable of 160 cfm at 55 dB(A).
 - .6 Remote control package with 24 V relay and transformer. Capable of being controlled and monitored by the BAS system.
 - .7 Fan on / off switch
 - .8 Disconnect switch
 - .3 Performance:
 - .1 As shown in the equipment schedules.
- 2.1.3. European Style Electrical Wall Heater
- .1 Acceptable Products:
 - .1 Indeeco EWI Series
 - .2 Ouellet OVE Series
 - .2 Construction:
 - .1 20 gauge steel grille
 - .2 Polyester powder coat finish. Coordinate colour with Architect and Owner.
 - .3 Surface mount.
 - .4 Element: stitched ribbon-type elements.
 - .5 Fan Motor: permanently lubricated totally enclosed motor. Each fan capable of 70 cfm at 42.5 dB(A).
 - .6 Remote control package with 24 V relay and transformer. Capable of being controlled and monitored by the BAS system.
 - .7 Fan on / off switch
 - .8 Disconnect switch
 - .3 Performance:
 - .1 As shown in the equipment schedules.
- 2.1.4. Small Electrical Wall Heater
- .1 Acceptable Products:
 - .1 Indeeco WLI Series
 - .2 Ouellet OVS Series
 - .3 Reznor EHL
 - .2 Construction:
 - .1 22 gauge steel grille

- .2 Polyester powder coat finish. Coordinate colour with Architect and Owner.
 - .3 Recessed mount / surface mount.
 - .4 Element: tubular steel finned elements.
 - .5 Fan Motor: permanently lubricated totally enclosed motor. Each fan capable of 40 cfm at 38 dB(A). (80 cfm at 41.3 dB(A))
 - .6 Remote control package. Capable of being controlled and monitored by the BAS system.
 - .7 Disconnect switch
 - .3 Performance:
 - .1 As shown in the equipment schedules.
- 2.1.5. Register Style Electric Wall Heater
- .1 Acceptable Products:
 - .1 Indeeco WRI Series
 - .2 Ouellet OVR Series
 - .2 Construction:
 - .1 20 gauge steel grille
 - .2 Polyester powder coat finish. Coordinate colour with Architect and Owner.
 - .3 Recessed mount / surface mount.
 - .4 Element: tubular steel finned elements.
 - .5 Fan Motor: permanently lubricated totally enclosed motor. Each fan capable of 40 cfm at 38 dB(A). (80 cfm at 41.3 dB(A))
 - .6 Remote control package. Capable of being controlled and monitored by the BAS system.
 - .7 Disconnect switch
 - .3 Performance:
 - .1 As shown in the equipment schedules.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Follow manufacturer's published installation instructions.
 - 3.1.2. Locate where shown on the Drawings.
 - 3.1.3. Recessed mount or surface mount as indicated.
 - 3.1.4. Install thermostat on wall away from direct flow of heated air.
 - 3.1.5. Connect to BAS as appropriate.
 - 3.1.6. Commercial Electric Wall Heaters
 - .1 Bottom of unit at least 250 mm (10 in) above finished floor and away from adjacent walls.
 - 3.1.7. Architectural Electric Wall Heaters
 - .1 Bottom of unit at least 250 mm (10 in) above finished floor and away from adjacent walls.

- 3.1.8. European Electric Wall Heaters
 - .1 Bottom of unit at least 300 mm (12 in) above finished floor.
- 3.1.9. Small Electric Wall Heaters
 - .1 Bottom of unit at least 250 mm (10 in) above finished floor.
- 3.1.10. Register Style Electric Wall Heaters
 - .1 Bottom of unit at least 250 mm (10 in) above finished floor.

END OF SECTION

23 82 39.20 Electric Unit Heaters

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
 - 1.2. SUBMITTALS
 - 1.2.1. Submit Shop Drawings of all items supplied in accordance with requirements of Section 20 05 03.00 - SHOP DRAWINGS.
 - 1.3. WARRANTY
 - 1.3.1. Provide a warranty in accordance with the requirements of Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
 - 2.1. MATERIALS
 - 2.1.1. Provide Electric Unit Heaters:
 - .1 Totally enclosed and thermally protected direct drive propeller fan and motor.
 - .2 Steel tubular heating element.
 - .3 High-limit temperature control with automatic reset.
 - .4 Fan delay to purge residual heat.
 - .5 Adjustable air outlet diffuser or adjustable louver cone diffuser.
 - .6 Enamel finish prime coated steel casing with minimum thickness of 1.27 mm (0.05 in. – 18 GA).
 - .7 Acceptable manufacturers include Ouellet, Reznor, Dimplex, Stelpro, Chromalox or Indeco.
 - 2.1.2. Provide wall thermostat with range 4.4 deg. C. to 26.7 deg. C. (40 deg. F. to 80 deg. F.). Program thermostat to cycle fan and electric coil. Acceptable manufacturers include Honeywell, Power, Johnson, Penn or White Rodgers.
 - 2.1.3. Provide Electric Unit heaters with capacities and other design parameters as shown in schedules.
 - 2.1.4. Provide electric unit heaters with a single point 208 1/60 electrical connection that powers all components including but not limited to
 - .1 Fan motor
 - .2 Control panel
 - .3 Safeties

3. Execution

3.1. INSTALLATION

3.1.1. Suspend unit heaters from ceiling or mount on wall as indicated.

3.1.2. Install in accordance with manufacturer's current installation guidelines.

END OF SECTION

26 01 00.00 Operating and Maintenance Instructions

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 03.00 – AS-BUILT DRAWINGS.
- 1.1.3. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.4. Section 26 08 00.00 – COMMISSIONING.
- 1.1.5. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.

2. Products

2.1. NOT USED

3. Execution

3.1. REQUIREMENTS FOR MANUALS

- 3.1.1. A minimum of three copies of complete and approved operating and maintenance instructions for all electrical equipment and systems shall be supplied before Substantial Performance of the Work. Provide additional copies if required under the General Requirements. In addition to the three copies of manuals, the contractor to provide a manual in a searchable PDF format on USB stick or sent via electronic transfer. As-Built Drawings to be included on the USB stick or sent via electronic transfer.
- 3.1.2. The contractor to identify the cost of AS-BUILT DRAWINGS and the Operation and Maintenance Manuals as a separate line item on their progress draw. The values to be broken out can be found in Section 26 05 03.00 – AS-BUILT DRAWINGS. The project will remain incomplete and no money will be released until the final versions, both hard and electronic, of the drawings and manuals are received and reviewed without comments.
- 3.1.3. Binders shall be three-ring, hard-cover, loose-leaf type and identified on the binding edges as "Maintenance Instructions and Data Book", for "Sterling Hall."
- 3.1.4. Terminology used in all the sections shall be consistent.
- 3.1.5. Volume One shall contain the master index of all systems, the name of the Contractor, Electrical Subcontractors and the date of Substantial Performance of the Work.
- 3.1.6. Volume One shall contain a section with all necessary warranty information.
- 3.1.7. Each binder shall have a complete index for all volumes.
- 3.1.8. Each binder shall be no more than half filled.
- 3.1.9. There shall be a separate section for all materials used on the project which fall under the WHMIS legislation. There shall be Material Safety Data Sheet (MSDS), hazard data sheet, for each of the materials.
- 3.1.10. There shall be a separate section for all Insurance Certificates, Test Certificates, Verification Forms and Test Forms.
- 3.1.11. All relevant information relating to a system or product shall be contained within one binder.

- 3.1.12. The manual sections shall follow the specification sections.
- 3.1.13. Any diagrams, installation drawings, single line diagrams charts, etc. shall be mechanically reduced while maintaining full legibility to standard page size. If this cannot be achieved, they shall be carefully folded and contained within a clear plastic wallet within the manual.
- 3.2. DATA FOR MANUALS
 - 3.2.1. Equipment data shall contain:
 - .1 Operating instructions.
 - .2 Operating conditions such as temperature and pressure.
 - .3 Location of equipment.
 - .4 Maintenance instructions and schedules for one-year routine.
 - .5 Recommended list of spare parts.
 - .6 Maintenance schedule.
 - .7 A trouble shooting table showing where to look for problems under various conditions of malfunction.
 - .8 All wiring diagrams.
 - .9 Equipment operating curves.
 - .10 Equipment nameplate data and serial numbers.
 - 3.2.2. System data shall contain:
 - .1 A listing of all systems.
 - .2 All panel, mcc and fire alarm schedules and locations.
 - .3 Equipment name tags.
 - .4 Cleaning, maintaining and preserving instructions for all material, products and surfaces. Include warnings of harmful cleaning, maintaining and preserving practices.
 - 3.2.3. Sub-Contractor manuals are required for:
 - .1 Switchboards and power distribution systems.
 - .2 Lighting systems.
 - .3 Emergency power systems.
 - .4 Fire alarm systems.
 - 3.2.4. As-Built documentation shall contain:
 - .1 Reviewed As-Built Shop Drawings.
 - .2 As-Built Construction Drawings.
 - .3 Originals of test forms.
 - .4 Originals of test certificates.
 - .5 Cyber Security Report Letter and backup schedule as required by Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 3.3. OPERATING INSTRUCTIONS
 - 3.3.1. Instruct the Owner's representative in all aspects of the operation and maintenance of systems and equipment.
 - 3.3.2. Instruct the Owner for a minimum of five (5) working days.

- 3.3.3. All instruction sessions to be video-taped and copy must be provided to the Engineer's Representative/owner.
- 3.3.4. Arrange for and pay for the services of engineers and other manufacturers' representatives required for instruction on the systems and the equipment as requested by the Engineer's Representative and/or the Owner.
- 3.3.5. At the time of final review, provide a sheet for each system and piece of equipment showing the date instructions were given. Each sheet shall show the duration of instruction, name of persons receiving instruction, other persons present (manufacturer's representative, Engineer's Representative, etc.), system or equipment involved and signature of the Owner's staff stating that they understood the system installation, operating and maintenance requirements. This information shall be inserted in the manuals after all instructions have been completed.
- 3.3.6. Review information with the Owner's representative to ensure that all information required has been provided.
- 3.3.7. Electrical equipment and systems included in the instruction requirements, include but not limited to the following:
 - .1 Switchboards and related power distribution equipment.
 - .2 Fire alarm systems.
- 3.4. TRIAL USAGE
 - 3.4.1. The Owner shall be permitted trial usage of systems or parts of systems for the purpose of testing and learning operational procedures. Trial usage shall not affect the warranties nor be construed as acceptance, and no claim for damage shall be made against the Owner for any damage or breakage to any part or parts due to the tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or workmanship of any kind.

END OF SECTION

26 05 01.00 General Instructions for Electrical Sections

1. General

1.1. WORK INCLUDED

- 1.1.1. Conform to the requirements of Division 1, which applies to and forms part of all sections of the work.

1.2. DESCRIPTION OF SECTION

- 1.2.1. The specification is divided into sections of work and a section may consist of the work of more than one subcontractor. The responsibility as to which electrical subcontractor provides labour, materials, equipment and services required to complete the work rests solely with the Electrical Contractor.

1.3. SECTIONS AFFECTED

- 1.3.1. These instructions apply to and form a part of all electrical sections.

1.4. DEFINITIONS

- 1.4.1. Where used on the Drawings or in the Specifications, the following words are given the meanings below.
- .1 Provide: means supply, install, connect, and test.
 - .2 Demolish: detach existing items and legally dispose of them off site.
 - .3 Remove and Reinstall: Detach existing items, prepare them for reuse, and reinstall them where indicated.
 - .4 Existing to Remain: existing items that are not removed and that are not otherwise indicated as being removed, removed and salvaged (turned over to Owner), or removed and reinstalled.
 - .5 Remove and Salvage: detach existing items and turn over to Owner.

1.5. SCOPE

- 1.5.1. Provide all labour, materials, equipment and services to complete the work of the electrical division as further specified and as shown on the drawings.
- 1.5.2. Should any discrepancy appear between any parts of the specifications and/or the drawings to cause doubt as to the true meaning and intent of the drawings and specifications, a ruling shall be obtained from the Engineer's Representative before submitting the tender. If this is not done the following will be assumed:
- .1 Where a discrepancy occurs between the specification and the drawings, the more expensive/onerous alternative will be deemed as included in the contract.
 - .2 Where a discrepancy occurs in the drawings the more expensive/onerous alternative will be deemed as included in the contract.
 - .3 Where a discrepancy occurs in the specifications the more expensive/onerous alternative will be deemed as included in the contract.

- 1.5.3. For any equipment/device where circuit numbers and/or panel designation labels are missing and not indicated on the drawings or specifications, a clarification shall be obtained from the Engineer's Representative before submitting the tender. If this is not done the Contractor shall power the equipment/device from the respective 120 V/208 V or 600 V electrical panel serving the equipment in that area at no additional cost to the Owner.
- 1.6. REGULATIONS
- 1.6.1. All work shall be performed in accordance with the latest codes, rules, regulations, by-laws and requirements of all authorities having jurisdiction except where the requirements of the drawings and specifications exceed the codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.
- 1.6.2. These specifications are supplementary to the requirements above.
- 1.6.3. Comply with all guidelines and standards issued by the authorities having jurisdiction.
- 1.6.4. Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the contractor shall notify the Engineer's Representative.
- 1.7. PERMITS, FEES, AND REVIEWS
- 1.7.1. Make submissions to obtain all permits. Include for and pay for all fees and arrange for all reviews required for the work of this division.
- 1.7.2. If required by code, plans and specifications have been previously submitted to the Authority Having Jurisdiction.
- 1.7.3. Furnish certificates of Acceptance from the Authority Having Jurisdiction and include them in the Operation and Maintenance manual.
- 1.8. VOLTAGE RATINGS
- 1.8.1. Operating voltages are as specified in CAN3-C235 (latest edition).
- 1.8.2. Motors, electric heating, control and distribution devices and equipment are to operate satisfactorily at 60 Hz within operating limits established by the above standard.
- 1.9. COORDINATION WITH MECHANICAL DIVISIONS.
- 1.9.1. Unless indicated otherwise on the Electrical Drawings, Electrical Contractor will be responsible for the supply and installation of the following:
- .1 Starters.
 - .2 Line and load side wiring for starters.
 - .3 Reduced voltage starters including "Soft Start" starters.
 - .4 Line and load side wiring to variable speed drives, including but not limited to wiring of associated harmonic filters, AC line input reactors, dV/dT filters, and output filters.
 - .1 Where harmonic filter is complete with a capacitor switching system, route a harmonic filter output conductor through the current transformer window within the harmonic filter. Coordinate with Mechanical Contractor and follow harmonic filter manufacturer's written instructions.
 - .5 Disconnect switches for all mechanical equipment.
 - .6 All power wiring (120 V & above) to all mechanical equipment.
 - .7 Electrical ramp heating cables and controls.
 - .8 All motorized damper power connections (120 V & above).

- .9 Fire alarm devices.
- .10 Wiring to electric space heaters.
- 1.9.2. Mechanical Divisions will be responsible for the supply and installation of the following:
 - .1 All variable speed drives and control wiring to starters.
 - .2 Pipe tracing and related controls.
 - .3 Electric hot water heaters.
 - .4 All electrical heaters including baseboard heaters, cabinet heaters, force flow heaters and radiant heaters.
 - .5 All interposing relays, relays, contactors and 120 V control devices.
 - .6 All 120 V and low voltage control wiring and conduits.
- 1.9.3. Should the Mechanical Contractor change any of the motor or equipment sizes from those identified on the Mechanical Schedules and Drawings at any stage of the project to aide their installation, the Mechanical Contractor will incur all extra electrical costs to revise the electrical feeders/wiring, breakers, fuses, starters and equipment to supply power to the revised piece of equipment.
- 1.9.4. Should the Mechanical Contractor provide alternates to any mechanical equipment selection by deviating from the make and model identified on the Mechanical Schedules and Drawings, the Mechanical Contractor will incur all extra costs to revise the electrical provisions including but not limited to feeders/wiring, breakers, fuses, starters and equipment to supply power to the alternate piece of equipment.
- 1.9.5. Where power for any flush valves, hands-free faucets, or other powered plumbing fixtures are shown on the Drawings, provide either a hard wired direct connection or a duplex receptacle, as required for the valve/faucet/fixture in question, based on coordination with the Mechanical Contractor.
- 1.9.6. Where large smoke dampers or large combination smoke and fire dampers, with multiple actuators per damper, are supplied by the Mechanical Contractor, extend the power connections and fire alarm monitoring and control connections shown on the Drawings to each and every actuator.
- 1.10. PLYWOOD BACKBOARDS, EQUIPMENT MOUNTING, & HOUSEKEEPING PADS
 - 1.10.1. Provide fire rated plywood backboards as shown on the Drawings and mount where all communication equipment is to be wall mounted. Plywood is to be 21 mm, urea-formaldehyde (UF) free and shall be either, Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI) or CSA Z809 - (latest edition) certified. Plywood to be either fire rated with the appropriate label displayed once installed or coated with fire retardant paint. Do not paint over plywood fire rating certification stamp. All Certification not to be painted.
 - 1.10.2. Surface mounted electrical equipment boxes are to be installed on galvanized strut channel stand-offs. Electrical equipment boxes shall include, but not be limited to electrical panels, low voltage lighting control, fire alarm, security, communication, electrical sub-metering, etc. Panels are to be grouped on common base wherever practical.
 - 1.10.3. Provide steel re-enforced concrete housekeeping pads under all floor mounted electrical equipment.
 - 1.10.4. Provide pre-cast steel re-enforced concrete pads under all outdoor ground mounted electrical equipment, unless a different support structure is detailed on the Drawings.
 - 1.10.5. Additionally, provide steel re-enforced concrete housekeeping pads where shown on the Drawings.

- 1.10.6. Provide all housekeeping pads with a minimum height of 100 mm above finished floor and do not extend beyond 50 mm beyond the electrical equipment unless shown otherwise on the Drawings. Ensure concrete pads fully cured for 28 days before installing equipment.
- 1.11. FINISHES
- 1.11.1. Metal enclosure surfaces are to be finished by the application of rust resistant primer on both the inside and outside, with at least two coats of enamel.
- 1.11.2. Clean and touch up all surfaces of equipment scratched or marred during shipment or installation. Match the original paint.
- 1.11.3. Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
- 1.12. SAFETY
- 1.12.1. Protect exposed live equipment during construction for personnel safety.
- 1.12.2. Shield and mark all live parts "LIVE 120 VOLTS", or with appropriate voltage in English.
- 1.12.3. Arrange for the installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of an electrician.
- 1.13. FIRE STOPS
- 1.13.1. Provide fire stops in accordance with front end, and Division 1 documents and as described herein. Contractor to coordinate fire stops with General Contractor.
- 1.13.2. Fire stops and smoke seal systems: in accordance with CAN/ULC-S115 (latest edition).
- .1 Asbestos free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of CAN/ULC-S115 (latest edition) and not to exceed opening sizes for which they are intended.
 - .2 Fire stop system rating for service penetrations: to suit the latest edition of the National Building Code of Canada with local amendments or the Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.
 - .3 Fire stop system rating for sealing junction of rated walls to rated floors and ceilings: to suit the National Building Code of Canada with local amendments or the Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.
- 1.13.3. Service penetration assemblies: certified by ULC in accordance with CAN/ULC-S115 (latest edition) and listed in ULC Guide No. 40 U19.
- 1.13.4. Service penetration fire stop components: certified by ULC in accordance with CAN/ULC-S115 (latest edition) and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15 under the Label Service of ULC.
- 1.13.5. Fire resistance rating of installed fire stop assembly not less than the fire resistance rating of surrounding floor and wall assembly, and in accordance with the National Building Code of Canada with local amendments or the Local/Provincial Building Code and meet requirements of local authority having jurisdiction.
- 1.13.6. Fire stops and smoke seals at openings intended for ease of re-entry, such as cables: elastomeric seal; do not use cementitious or rigid seal at such locations.
- 1.13.7. Fire stops and smoke seal all electrical penetrations through rated assemblies as per ULC Standards.
- 1.13.8. Where sound and vibration control is required, use an elastomeric seal; do not use a cementitious or rigid seal at such locations.

- 1.13.9. Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- 1.13.10. Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- 1.13.11. Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- 1.13.12. Sealants for vertical joints: non-sagging.
- 1.13.13. Colour: if range available to Engineer's Representative's choice of standard colours, generally to match background colour where visible in finished spaces.
- 1.13.14. Through non-fire or non-smoke separations or where waterproof membrane is field applied, where pipes are insulated, sleeves shall be sized to accommodate the insulation and vapour barrier.
- 1.13.15. Where-holes are core drilled in existing structures, sleeves shall be provided as specified complete with fire stopping as noted above.
- 1.13.16. Submit a complete fire stop system shop drawing package, identifying the products that may be used on the project. Prior to submitting data, review with Authority having Jurisdiction to confirm acceptability of proposed materials and assemblies.
- 1.13.17. Installation
 - .1 Install fire stops and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.
 - .2 Seal-holes or voids made by through penetrations, poke through termination devices, and un-penetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
 - .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
 - .4 Tool or trowel exposed surfaces to a neat finish.
 - .5 Remove excess compound promptly as work progresses and upon completion.
- 1.14. ACOUSTIC TREATMENT
 - 1.14.1. Electrical Contractor will be responsible for coordinating the electrical installation with the recommendations of the acoustic consultant and their report where one has been included in the contract documents.
 - 1.14.2. Refer to the recommendations of the acoustic report where provided, and provide and install acoustic treatments as necessary. This may include separation of receptacles in stud bays, sealing of junction boxes, application of sound insulating materials etc. Coordinate the installation of these materials with the General Contractor and Drywall/Partition Subtrade.
 - 1.14.3. Do not install back to back receptacles/back boxes within the same stud bay wherever possible. Where it is not possible to stagger receptacles, provide acoustic seal around receptacle/back box to provide acoustic isolation/separation of spaces.
- 1.15. HOISTING
 - 1.15.1. Electrical Contractor will be responsible for the hoisting of all the equipment in the contract. Contractor to coordinate with General Contractor for use of the general hoisting facilities. If hoist facilities are inadequate, then subcontractors must provide their own. Subcontractors must inform general contractors in writing of requirements before tender closing date. Any hoisting required in addition to that provided by the General, will be included in the bid price.

- 1.15.2. Electrical Contractor to include for the qualified millwrights to move and place all equipment over 1000 lbs. Contractor to provide proof of millwright certification.
- 1.16. CLEANING AND WASTE REMOVAL
- 1.16.1. Clean all electrical equipment that has been exposed to construction dust and dirt.
- 1.16.2. Contractor to clean all electrical equipment, inside and out, prior to turn over to Owner. Equipment is subject to review by Engineer's Representative and/or Owner.
- 1.16.3. Contractor is responsible to remove their own waste from the site. All re-usable materials shall be recycled.
- 1.17. SPRINKLERS
- 1.17.1. All electrical equipment shall be suitable for installation in a sprinklered environment and enclosures are to be CSA Type 1 with drip hood, sprinkler proof enclosure unless otherwise noted.
- 1.18. TEMPORARY LIGHT AND POWER
- 1.18.1. Temporary light and power for construction shall be provided, metered, and maintained by the electrical trade, as directed by the General Contractor; but each trade shall provide all extension cords, lamps, etc., required to complete their work.
- 1.18.2. All temporary light to be LED. Provide adequate lighting to meet all health and safety standards.
- 1.19. EXAMINATION AND PROTECTION OF SITE
- 1.19.1. Before submitting Bid, each trade shall examine the site to determine the conditions which may affect the proposed work. No claims for extra payment will be considered because of failure to fulfil this condition.
- 1.19.2. Contractor to document any existing conditions on site and submit a pre-condition survey including pictures. Contractor will be responsible to return the site back to its original form, which includes but is not limited to ground repair including grading and new sod and repair of damaged walls, doors and/or floors.
- 1.19.3. Contractor is to protect trees and plants on site and on adjacent properties. Plants to be protect with burlap. Trees and roots within construction area to be protected by the erection of temporary 2 m high plywood hoarding at the drip line of the tree. Contractor to avoid unnecessary traffic, dumping and storage of materials at or near trees or plants.
- 1.19.4. When requested by the Owner and/or Engineer's Representative, the Contractor is to provide digital pictures of the site, including but not limited to progress of work and installed equipment, via e-mail to the Owner and/or Engineer's Representative.
- 1.20. DRAWINGS AND INSTALLATION
- 1.20.1. The drawings are intended to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operative installation.
- 1.20.2. The location, arrangement and connection of equipment and materials shown on the drawings represent a close approximation to the intent and requirements of the contract. The right is reserved by the Engineer's Representative to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.

- 1.20.3. Certain details indicated on the drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence on the drawings.
- 1.20.4. The actual location of switches, outlets and luminaires, etc. shall be reviewed by the Engineer's Representative before installation.
- 1.20.5. The location and size of existing services shown on the drawings are based on the best available information. The actual location of existing services shall be verified in the field before work is commenced. Particular attention shall be paid to buried services.
- 1.20.6. Changes and modifications necessary to ensure co-ordination and avoid interference and conflicts with other trades or to accommodate existing conditions, shall be made at no extra cost to the Owner.
- 1.20.7. Leave areas clear where space is indicated as reserved for future equipment, and equipment for other trades.
- 1.20.8. Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.
- 1.20.9. Where equipment is shown to be 'roughed-in only' obtain accurate information from the Engineer's Representative before proceeding with the work.
- 1.20.10. Contractor is to review Architect's specifications, drawings and details to confirm locations of devices and equipment.
- 1.20.11. This Contractor is responsible to mark-out his work, fully coordinated with all other trades, in sufficient time for review by Architectural Consultant prior to rough-in. Prepare dimensioned layouts of each room prior to rough-in for review by Architectural Consultant. Do not proceed with any work until the Architectural Consultant has reviewed the layout drawings.
- 1.20.12. The Contractor will reimburse the Engineer's Representative for their time spent on answering any written questions or requests for information where the answer is clearly identified on the drawings or in the specifications.
- 1.21. INSTALLATION, INTERFERENCE AND SETTING DRAWINGS
 - 1.21.1. The Contractor is to complete installation, interference and setting drawings, dimensioned and to scale for all systems. They shall be made available for review by the Engineer's Representative, if requested. The drawings are required to make clear the work intended or to show its relation to adjacent work or to the work of other trades. When an alternative piece of equipment is to be substituted for equipment shown, drawings of the area involved shall be prepared by this division.
 - 1.21.2. Slab layout drawings are to be submitted for review by the Structural Engineer's Representative. These slab layout drawings are to be included in the as-built drawings. Refer to Section 26 05 03.00 – AS-BUILT DRAWINGS.
 - 1.21.3. Interference drawings are required for shafts, ceiling spaces, basement areas, typical floors and wherever there is possible conflict in the positioning of electrical equipment, piping, ductwork sub-trades or architectural features.
 - 1.21.4. This Division shall prepare sleeving drawings indicating the size and locations of openings required in concrete floor slabs, roof slabs/decks and walls for conduit, bus ducts and equipment for review by the Structural Engineer and Architect. In case of failure to provide information in time (i.e. before the concrete is poured) any extras incurred shall be at the expense of this Division.

1.22. SUPPLEMENTARY BID FORM AND SUBMISSIONS OF BID

- 1.22.1. Submit with tender, if included in the documents, a complete Electrical Supplementary Bid Form. Tenders not completed in full may, at the discretion of the Owner be rejected.
- 1.22.2. Several alternative, separate and itemized prices may have been requested. These shall be completed on the Electrical Supplementary Bid Form. Refer to the specific sections of the specifications and to the drawings for details.

1.23. APPROVED MANUFACTURERS

- 1.23.1. Where only one name appears in the specification, the bid shall include for the specified equipment.
- 1.23.2. Where two or more names are shown in the specifications as alternates or equal to, this division can select which manufacturer is to be carried.
- 1.23.3. The Contractor is to list substitute equipment as a price deduction to the Bid Price on the Electrical Supplementary Bid Form. Space has been provided to show manufacturers not specifically mentioned. Acceptance of substitute equipment shall be at the discretion of the Owner and/or Engineer's Representative. Any substitutes not listed on the Electrical Supplementary Bid Form will not be entertained.
 - .1 The proposed substitution shall show product name and complete description and also what difference, if any, will be made in the amount of the Bid Price for each substitution, should it be accepted.
 - .2 Materials and products specified by the name of the manufacturer, the brand or trade name, or catalogue reference, shall be the basis of the Bid Price.
 - .3 Any alternate and/or substitute equipment listed shall be equal in performance and quality to that specified. If space, power, structural or any other requirements are different from the equipment specified, the cost of any changes shall be included for in the price shown on the Electrical Supplementary Bid Form.
 - .4 The Owner reserves the right to accept or reject any substitution without question.
 - .5 The "Base and Alternate Equipment" is for North American manufactured products. Where a listed manufacturer can offer either North American or non-North American source for the equipment, the country of origin shall be shown under "Substitute Equipment" and the cost savings shown under "Deduct from Tender Price".

1.24. PRODUCTS AND MATERIALS

- 1.24.1. Make and quality of materials used in the construction of this project shall be subject to the approval of the Engineer's Representative.
- 1.24.2. All equipment and material are to be CSA certified or approved by an accredited organization. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Authorities.
- 1.24.3. Factory assemble control panels and component assemblies.
- 1.24.4. Materials and equipment supplied by this division shall be new and free from defects and shall be equivalent in physical characteristics and performance to that specified by the manufacturer's name and catalogue reference.
- 1.24.5. Where a certain manufacturer's equipment has been specified by name or model number, the contractor shall be responsible for ensuring that the performance and quality meets the specified equipment and that the same access or maintenance space is available for an alternative manufacturer's equipment that is used and that interfacing connections with other trades can be made at no extra cost.

- 1.24.6. Within 30 days of the award of contract, the Contractor is to submit a complete list of the manufacturers for all equipment being supplied on the project.
- 1.24.7. Availability
- .1 In submitting Bid, Contractor warrants that all materials are available in suitable time to meet Contract dates.
 - .2 Subject to sentence .3 below, where the Contractor advises that the Contractor cannot supply materials in suitable time to meet Contract dates, and should it subsequently appear that Work may be delayed for such reason, the Engineer's Representative reserves the right to substitute more readily available products of similar character, even if more costly to the Contractor, at no increase in Contract Price.
 - .3 Where the Contractor can show that the Contractor promptly ordered the originally specified materials the Owner will pay the differential in cost between the originally specified material and the substitute material without any mark-ups applicable by the Contractor, subcontractors, sub-subcontractors or suppliers. For greater certainty, the Contractor's failure to submit shop drawings or other submittals or seek direction in those instances where the Contract Documents so require in sufficient time to permit ordering materials is not cause for the Owner to pay the cost differential in sentence .2 above.
- 1.25. CO-OPERATION WITH CONSULTANTS
- 1.25.1. To assist in the successful execution of the project, the Contractor shall receive a job report that summarizes the expectations of the Consultant and the Contractor. This document covers topics such as progress billings breakdowns, shop drawing requirements, change order pricing breakdowns, the commissioning process, installation drawings, the specifications, as-built drawings and O+M manuals, along with a number of other items. This job report is intended to reiterate and elaborate on key items of the Contract Documents and is not intended to impose new requirements.
- 1.25.2. At the appropriate time during construction the Contractor shall submit the applicable documentation listed in the "Mechanical/Electrical Unfinished Building Occupancy Checklist". The list shall be issued by the Consultant during the course of the project; however, a sample checklist can be provided at any time upon request. The checklist shall be completed by the Contractor when the information required for occupancy is submitted. The Consultant shall review the information and checklist and shall identify when the information is complete. The Consultant's general review letter (required for building occupancy) shall only be issued when all the information requested in the checklist is submitted by the Contractor and deemed to be complete by the Consultant.
- 1.25.3. For electrical systems occupancy, provide a PDF copy of the following documents to the Engineer's office for review:
- .1 Electrical inspection authority inspection certificate/report with no deficiencies.
 - .2 Fire alarm verification report with no deficiencies.
 - .1 Ensure that the verification report meets the requirements for verification reports indicated in the Fire Alarm specification section, including the inclusion of audible sound pressure levels and testing with doors closed. Additionally, ensure that the sound pressure levels in the report comply with the minimums, maximums, and minimum levels above ambient stated in Part 3 of the applicable Building Code. Ensure that the report addresses maglocks and music system mute signal, where applicable to the project.
 - .3 Maglock test and verification report with no deficiencies.

- .4 CAN/ULC-S561 "Standard for Installation and Services for Fire Signal Receiving Centres and Systems" certificate.
 - .5 CAN/ULC-S1001 "Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems" reports for electrical systems with no deficiencies.
 - .1 Ensure that the report addresses all systems indicated in the "Life Safety Integration Testing" clause within this specification section.
 - .6 Letter confirming that all emergency lighting and exit signs are installed and illuminated and stating that emergency lighting and exit signs are installed in conformance with the Contract Documents.
 - .7 Letter confirming that all unit equipment for emergency lighting (batteries, heads, exit signs) are installed and powered and have been tested to demonstrate that they last for the run time indicated in the Specifications or on the Drawings. State the applicable run time in the letter. Additionally, ensure that letter states that emergency lighting and exit signs are installed in conformance with the Contract Documents.
 - .8 Letter with written confirmation that all new, relocated, or reinstalled ceiling luminaires are supported from the building structure, independent from the suspended ceiling, in accordance with the requirements of the Lighting Equipment specification section.
 - .9 Emergency generator testing and commissioning reports with no deficiencies.
 - .10 Emergency generator TSSA inspection report with no deficiencies.
 - .11 Fire pump testing and commissioning reports with no deficiencies.
 - .12 Emergency power (inverter) testing report with no deficiencies.
 - .13 Letter confirming that all openings in walls and floors for electrical services have been fire stopped.
 - .14 Cyber Security Report Letter and backup schedule as required by Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - .15 Lighting control commissioning documentation.
 - .16 Hood fire suppression certificate of acceptance by third party testing agency or signed and sealed letter of assurance from hood fire suppression engineer.
 - .17 Letter confirming that all breaker trip unit/protective relays settings have been set in accordance with the power system study.
 - .18 Additional items as indicated by the Engineer's Representative.
 - .19 Additional items as indicated on the Occupancy of Unfinished Buildings Checklist issued by Engineer's Representative.
- 1.26. CO-OPERATION WITH OTHER DIVISIONS
- 1.26.1. Particular attention must be paid to the proximity of electrical conduit and cable to mechanical piping and equipment.
 - 1.26.2. Electrical conduits shall not touch or be supported on pipe or duct walls.
 - 1.26.3. Each section shall confine itself to installing all materials in the spaces shown without encroaching upon space for materials installed under other sections or divisions. Where the space allocated to another section or division is encroached upon, the materials shall be relocated to their proper space allocation in such a manner to complete the work using space allocated to the various sections and divisions. Relocation of materials and work involved shall be paid for by the section responsible for the encroachment at no extra cost to the Owner.
 - 1.26.4. The supply of all items is to have built-in to the delivery schedule, ample time for rapid progress of work. Proceed with work determined by the construction schedule.

- 1.26.5. The Electrical Contractor shall coordinate the exact breaker/fuse sizes with all mechanical equipment shop drawings prior to rough-in and ordering of the electrical distribution equipment. Size of breakers/fuses shown on drawings are based on generic equipment manufacturers and sizes may change depending on successful equipment manufacturer. No additional costs shall be allowed for non-coordinated mechanical shop drawing reviews by the Electrical Contractor.
- 1.27. TEMPORARY USE OF EQUIPMENT
- 1.27.1. Where the electrical systems are operated during construction, the Electrical Contractor shall maintain the system and equipment in proper operating condition.
- 1.27.2. Before any area of the building is turned over to the Owner for acceptance and for beginning of the guarantee/warranty period, the systems and equipment shall be returned to the initial new condition.
- 1.27.3. Permanent electrical equipment is only to be used upon permission of Owner and Engineer's Representative and is only to be used on a limited basis. All equipment must be cleaned prior to turnover.
- 1.28. TESTING
- 1.28.1. General
- .1 Refer to the testing requirements outlined in each individual specification section and provide all required staffing, materials, tools and expertise to perform the required testing. Where specification Section 26 08 01.00 - TECHNICAL SERVICES DIVISION STARTUP SERVICE has been included, ensure all testing is performed accordingly by the Technical Services Division Startup Service trade.
 - .2 This specification is intended to capture the requirements for factory testing, factory witness testing, site startups, site testing and training of electrical equipment. This specification represents a minimum requirement and does not absolve the equipment manufacturers from performing any tests required by the standards referenced in the individual specification sections.
 - .3 The testing process for the Electrical Systems shall include:
 - .1 Verification that the installation meets the requirements of the contract documents.
 - .2 Verification that the system's performance meets the design intent.
 - .3 Building operator training.
 - .4 As-Built documentation, operating and maintenance manuals, and systems operating manuals.
 - .4 The Contractor, Engineer's Representative, Technical Services Division Startup Service (where called for in the Specification) and Commissioning Agent (where identified as part of the project) shall provide the services to complete the process. See further explanation below defining the areas of responsibility.
 - .5 Provide labour, equipment and material to conduct the testing process as outlined in this Section.
- 1.28.2. Factory testing
- .1 All equipment is to have factory testing performed by the equipment manufacturer. These tests are to include the manufacturers standard factory testing, and any required testing to conform to the standards, and any additional testing referenced in the individual specification sections.

- .2 The manufacturer is to perform the required testing and submit test reports recording the results of all tests to the Electrical Contractor for review and if found acceptable submit to Engineer's Representative for Shop Drawing review and the final copy included in the O&M Manuals. Test reports are to be submitted and reviewed by the Electrical Contractor and Engineer's Representative prior to shipment to site.
- .3 Any deficiencies noted in the factory testing are to be corrected prior to shipment of electrical equipment unless otherwise agreed to by the Electrical Contractor.

1.28.3. Factory Witness Testing

- .1 For all factory witness testing, the manufacturer is to act as the test leader and is responsible for all required organization, coordination, performance of testing and documentation of test results. The manufacturer is to ensure the tests being performed are in alignment with the requirements of the Specification in advance of the testing and provide hard copies of the latest Shop Drawings and test scripts for each attendee of the witness test. Any deviations to the tests being requested in the Specifications and Drawings must be communicated to the Electrical Contractor and Engineer's Representative in advance and must be accompanied with a rationale and/or an alternate test method that demonstrates that the intent of the specified test would be met.
- .2 Each factory witness test is to include at a minimum:
 - .1 Introductions.
 - .2 A walkthrough of the latest Shop Drawing and review of latest Shop Drawing commentary with discussion on any remaining open items.
 - .3 A walkthrough of the test script.
 - .4 A walkthrough of the Design Specifications and Drawings noting/reiterating any required deviations from the design documents in terms of testing requirements.
 - .5 Performance of tests
 - .6 At the conclusion of all factory witness tests, the manufacturer is to produce signed factory test results recording all noted results and documenting any remaining deficiencies. Report to include record of the testing instruments used along with calibration dates (where required) and serial numbers.
- .3 Factory witness testing shall be attended by the persons as listed below, attendance at the witness testing is at the discretion of each representative and is to be confirmed by all parties prior to witness testing.
 - .1 One (1) Electrical Contractor Representative
 - .2 One (1) Engineer Representative
 - .3 One (1) Commissioning Agent Representative
 - .4 One (1) Technical Services Division Startup Service Representative
- .4 Manufacturers to include for the complete cost of the attendees listed above to attend the factory witness testing for the equipment. Cost to include but not limited to all travel, food and lodging costs. Manufacturer to note, attendees may be coming from different locations within Canada.
- .5 Manufacturer to provide factory witness test scripts to the Contractor as a formal Shop Drawing in advance of the factory witness test for review by the Contractor, Engineer and Commissioning Agent through the formal Shop Drawing review process. Factory witness test shall not be scheduled without a reviewed test script.
- .6 Manufacturer to notify the attendees minimum two (2) weeks prior to the date the tests are to be performed. Where travel out of province is required, provide minimum four (4) weeks notice.

- .7 Manufacturer to perform their own internal quality assurance and control check prior to any factory witness test such that the manufacturer is prepared to perform the complete demonstration of the equipment.
- .8 Any deficiencies noted in the factory testing is to be corrected prior to shipment of the electrical equipment.
- 1.28.4. Site Startup
 - .1 Manufacturer to include for the costs of technician(s) to perform initial system startup on site as required by the Specifications and Electrical Contractor. Extent of technician(s) involvement to be coordinated with the needs of the Specifications and the Electrical Contractor.
- 1.28.5. Site tests
 - .1 Manufacturer to include for the costs of technician(s) to perform site tests as required by the Specifications and Electrical Contractor. Refer to tests identified in the individual Specification sections and include all personnel and equipment to perform testing.
- 1.28.6. Materials
 - .1 The Contractor and Manufacturer shall provide all instrumentation and equipment necessary to conduct the tests as specified in the specifications. The Contractor shall ensure the instrumentation to be used are properly and adequately calibrated and if required by the Engineer's Representative or Commissioning Agent to provide the dates the instrumentation was last calibrated.
- 1.29. WARRANTY
 - 1.29.1. Except where longer warranty periods are required by other specification sections, provide a one (1) year warranty for the Work, starting at Substantial Performance of the Work.
 - 1.29.2. Coordinate the extension of manufacturer warranties to comply with the clause above, based on the duration of construction.
- 1.30. TRAINING
 - 1.30.1. The Manufacturer is to include for qualified technician(s) with project specific knowledge to perform in depth training for facility management team members.
 - 1.30.2. Training may include up to ten (10) attendees and may be video recorded by others.
 - 1.30.3. Training program to include:
 - .1 One site 'in class' introduction session covering the basics of system operation.
 - .1 Manufacturer to submit a course outline before training commences.
 - .2 Manufacturer to provide course training documentation (if required) for attendees.
 - .2 On site 'hands on' session covering the specific equipment design and operation details, including:
 - .1 All operating procedures including automatic and manual intervention procedures.
 - .2 All regular maintenance procedures.
 - .3 Troubleshooting procedures.
 - .4 Spare parts required.

- 1.30.4. Timing of training to be coordinated with Electrical Contractor and Owner/Facility Management staff and is to be provided in advance of systems supporting critical loads to allow for full ability to operate the systems. The Electrical Contractor/Manufacturer to notify the Owner/Facility Management team a minimum two (2) weeks prior to the date of training.
- 1.31. LIFE SAFETY INTEGRATION TESTING
- 1.31.1. Provide testing of the integration of all life safety and fire protection systems.
- 1.31.2. The Integrated Testing Coordinator (ITC) will complete an Integration Testing Plan (ITP). Carry out the testing as described by the ITC in the ITP, and in accordance with CAN/ULC-S1001 as it relates to any electrical systems.
- 1.31.3. The ITC and development of the ITP are not the responsibility of this Contractor.
- 1.31.4. The testing of the integrated systems shall include, but not be limited to the following systems and all associated components:
- .1 Fire Alarm System
 - .2 Fire Signal Receiving Centre
 - .3 Mass Notification
 - .4 Elevators
 - .5 Emergency Generators and/or Inverters
 - .6 Audio/Visual Systems
 - .7 Lighting Control Systems
 - .8 Notification Systems (Public Address)
 - .9 Sprinkler Systems
 - .10 Standpipe Systems
 - .11 Fire Pumps
 - .12 Water Supplies
 - .13 Water Supply Control Valves
 - .14 Heat Tracing for Life Safety Systems
 - .15 Fixed Fire Suppression Systems
 - .16 Cooking Equipment Fire Suppression Systems
 - .17 Automatic Door Operators for Stair Relief
 - .18 Hold-Open Devices
 - .19 Electromagnetic Locks
 - .20 Smoke Control Systems and Associated Dampers
 - .21 Venting to Aid Firefighting
 - .22 Smoke Alarms
 - .23 Hazardous Protection Monitoring
 - .24 Gas / CO Detection Systems
 - .25 Prevention of Smoke Recirculation (AHUs)
- 1.31.5. Coordinate with all other trades to carry out the appropriate testing.
- 1.31.6. Be responsible for carrying out and coordinating the testing work associated with the ITP. All work shall be coordinated with the ITC and shall include but not be limited to:

- .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
- .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
- .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001 "Integrated Systems Testing of Fire Protection and Life Safety Systems."
- .4 Provide fire alarm verification report along with all other documentation requested by the ITC as it relates to the electrical systems in conformance with CAN/ULC-S1001 "Integrated Systems Testing of Fire Protection and Life Safety Systems."

1.32. STATEMENT OF PRICES

- 1.32.1. To form a basis for progress payments the successful bidder shall submit a sample progress draw for the various portions of the work. The format of the sample progress draw shall be as shown in the example progress draw below. The sample progress draw shall include a breakdown which illustrates all categories shown on the example progress draw which are relevant to the project. The categories shall be broken down to clearly illustrate the value of the material being supplied as the first subcategory and the value of the labour being supplied as the second subcategory, as shown on the example progress draw. The electrical Engineer's Representative reserves the right to request that additional categories be added to the progress draw if the Engineer's Representative feels that doing so will aid in assessing the contractor's progress on site, thereby expediting contractor payment. Progress draws not including the categories shown on the example progress draw where relevant to the project and / or not providing separate labour value and separate material value subcategories will be rejected.
- 1.32.2. The total price of all portions of the work shall equal the total price of the work covered under the electrical division. Cost for as-built drawings and manuals to be carried as a separate line item.
- 1.32.3. Contractor to list and track all fixed per unit cost luminaires as part of Light Fixtures - Materials on the progress draw.
- 1.32.4. Contractor to list and track each of the approved changes on separate lines on the progress draw.
- 1.32.5. Provide progress draw where the amount claimed is for the value, proportionate to the amount of the Contract, of Work performed and Products delivered to the Place of the Work as of the last day of the payment period. Do not include items on the progress draw which don't meet these conditions.
- 1.32.6. Costs of temporary facilities and utilities shall be amortized over the duration of the Work. Claims for 'mobilization', 'bidding costs', or similar lump sums at or before start of work are not acceptable.

EXAMPLE PROGRESS DRAW

Electrical Contractor Name
 Billing Application Electrical Division
 Project Name

Application Number – xx			Date – xxxx to xxxx					
<u>Description</u>	<u>Contract Value</u>	<u>%</u>	<u>Billed To Date</u>	<u>%</u>	<u>Prev. Billed</u>	<u>%</u>	<u>This Billing</u>	<u>Balance to Complete</u>
Permits / Mobilization	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx

Demolition & Removals	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Duct Banks – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Duct Banks – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Wire – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Wire – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Ltg. Branch Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Ltg. Branch Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Lighting Branch Wire – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Lighting Branch Wire – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Cable – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Cable – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Cable – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Cable – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Distribution Equipment – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Distribution Equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Generator / Inverter – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Generator / Inverter – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Light Fixtures – Material†	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Light Fixtures – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Lighting Controls – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Lighting Controls – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Equipment – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Wiring Devices – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Wiring Devices – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Hand Dryers – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Hand Dryers – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Commissioning / Training	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Demobilization / Clean-up	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Manuals / As-Built Drawings	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Subtotal	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx

Additions to Contract								
CO # / PC # / CCN #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
Cash Allowance #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
	-----		-----		-----		-----	-----
Subtotal	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
	-----		-----		-----		-----	-----
Total Contract	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Less Holdback			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	
			-----		-----		-----	
Total			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	

[†] Inclusive of fixed per unit cost luminaires. Refer to luminaire schedule and/or electrical supplementary bid form for luminaire fixed unit costs.

1.33. METRIC CONVERSIONS

1.33.1. Particular care shall be taken with imperial versus S.I. metric conversions. This applies to all services including, but not limited to, equipment, conduit and site services in both new and existing installations.

1.34. INTERRUPTION OF SERVICES

- 1.34.1. Any interruption of the electrical services to any part of the building shall come at a time agreeable to the Engineer's Representative. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.
- 1.34.2. Testing and operation of major equipment shall be approved by the Engineer's Representative to avoid excessive electrical utility charges. Such testing to be generally carried out after normal working hours or on weekends.
- 1.34.3. All such overtime work shall be carried out without additional cost to the Owners.
- 1.34.4. Modifications to existing electrical equipment, which will require shutdown, must be coordinated with the Owner and will only be permitted on weekdays from 10:00 pm to 6:00 am and on weekends from Friday at 7:00 pm to Sunday 6:00 pm. Exact weekends to be co-ordinated with the Owner. Consecutive weekends of shutdowns will not be allowed. Contractor to pay for all utility costs associated with shutdowns. Any work not associated with live equipment can be done during normal working hours. Work considered disruptive to the normal operation of the building will be done after normal business hours. Exact times to be co-ordinated with Owner.
- 1.34.5. Contractor to provide a minimum of 5 days written notice of a requirement for a shutdown. Contractor to include for separate meetings with the Owner and Engineer's Representative to discuss the shutdown in detail and to coordinate all the work being performed.
- 1.34.6. The Contractor is responsible for co-ordination and isolating of all existing services at all voltage levels required for the disconnections and connections to existing buildings. This includes shutting down and isolating existing low and medium voltage services. The owner will not perform any isolations for the contractor but will be present during the work. The contractor is to use qualified personnel for these shutdowns ensuring compliance with all applicable safety requirements.
- 1.34.7. The Contractor is responsible for any damages caused to existing systems when making connections.

- 1.34.8. The Contractor is to keep shutdowns of existing buildings to a minimum by scheduling the work and providing the required number of personnel to keep the shutdown to a minimum. This Contractor is to include for as many multiple teams of electricians as is feasible to keep the shutdown work to a minimum.
- 1.35. PRE-PURCHASED EQUIPMENT
- 1.35.1. The Electrical Trade shall assume complete responsibility for the Owner's pre-purchased equipment and its associated equipment as if it had been purchased by the Contractor, with the single exception of payment.
- 1.35.2. The Electrical Trade shall provide a warranty for all pre-purchased equipment during the warranty period and shall include for all labour, material and shipping charges not covered in the manufacturer's warranty to completely repair or replace any defective pre-purchased equipment at no cost to the Owner during the warranty period.
- 1.35.3. The Electrical Trade shall take complete responsibility for the co-ordination of delivery of the separate items of equipment and their proper placement as required by jobsite conditions.
- 1.35.4. The Electrical Trade shall provide all materials and labour required to incorporate pre-purchased equipment into a working system whether or not shown on the Drawings or specified herein.
- 1.35.5. The following list of equipment is pre-purchased:
.1
- 1.36. PRE-TENDERED EQUIPMENT
- 1.36.1. The Electrical Trade shall assume complete responsibility for the Owner's pre-tendered equipment and its associated equipment as if it had been purchased by the Contractor, including payment.
- 1.36.2. The Electrical Trade shall provide a warranty for all pre-tendered equipment during the warranty period and shall include for all labour, material and shipping charges not covered in the manufacturer's warranty to completely repair or replace any defective pre-tendered equipment at no cost to the Owner during the warranty period.
- 1.36.3. The Electrical Trade shall take complete responsibility for the co-ordination of delivery of the separate items of equipment and their proper placement as required by jobsite conditions.
- 1.36.4. The Electrical Trade shall provide all materials and labour required to incorporate pre-tendered equipment into a working system whether or not shown on the Drawings or specified herein.
- 1.36.5. The following list of equipment is pre-tendered: Insert the list of Owner Pre-tendered equipment or delete this if none are being included in the project
.1
- 1.37. VALUATION OF CHANGES
- 1.37.1. Further to contract requirements, the method to be used in determining the value of a change to the Work, by either Change Order or Change Directive, shall be:
.1 Estimate and acceptance in a lump sum, unless the Engineer's Representative otherwise determines that the method shall be unit prices set out in the Contract.
- 1.37.2. Contractor shall provide the Engineer's Representative with a detailed cost analysis of the contemplated change indicating:
.1 Quantity of each material.

- .2 Unit cost of each material.
 - .3 Time involved.
 - .4 Sub-trade quotations including a complete analysis of costs.
 - .5 Mark-ups, if applicable.
 - .6 Value of GST or HST, as applicable.
 - .7 Proposed change in Contract Time.
- 1.37.3. The detailed cost breakdown is to list material and labour separately for each item on the proposed change. The breakdown for contemplated change is to follow the format of the attached document.
- 1.37.4. The following shall not be included in the cost of the work but are covered by the hourly labour rate:
- .1 The Contractor's payroll, administrative, head office and site office expenses, including stationary, postage and other office supplies.
 - .2 The costs of the Contractor's Project Manager, clerical and administrative personnel, and executive personnel.
 - .3 Use of temporary offices, sheds, small/hand tools, storage, and site office consumables, etc., including but not limited to the cost of telephone, light, power, water and heat used therein.
 - .4 Transportation and overnight room expenses for out of town labour, if local labour is unavailable.
 - .5 Insurance premiums, all government payroll burdens, variable labour factors and union or association funds.
 - .6 Licenses and permits, except when these are special for a particular item of work.
 - .7 Printing charges for Proposed Changes, Change Orders and Drawings for Contractor's and Subcontractors' use in the work. Engineer's Representative will provide a PDF electronic copy of change notice documentation.
 - .8 The cost of preparing As-Built, layout and working drawings and shop drawings. This includes any and all AutoCAD/BIM costs related to interference drawings or other associated drawings that may be required as part of the changes.
 - .9 The cost of clean-up and disposal of waste material.
 - .10 Parking, travel, coffee break/rest periods, warranties, safety training, WHMIS and health and safety committee, and non-productive time.
 - .11 Rentals, additional bonding, project financing.
- 1.37.5. The Contractor shall not be entitled to any additional compensation arising out of changes to the Work other than the amounts determined and agreed to under CCDC 2-2020 GC 6.2.
- 1.37.6. The Contractor shall inform the Surety Company or Companies who have issued any bonds for this Contract, and any Insurers who have insured any part of the work or operations or who have an interest in this Contract, of all changes in the Contract. Pay all costs of any changes in bonds or insurances required to maintain bonds or insurances in conformance with the requirements of the Contract Documents. Provide Owner immediately with any revised bonds or insurances.
- 1.37.7. Special equipment rental rates will be charged at cost. The Contractor shall provide an official quotation of the equipment rental with the Proposed Change quotation as backup, otherwise special equipment rentals will not be accepted by the Owner/Consultant.
- 1.37.8. The maximum percentage fee for mark-ups shall be as stated in the Division 0/1 specifications or the Contract Supplementary Conditions.

- 1.37.9. All changes, change notices, revisions to contract, Supplemental Instructions, change directives or any additional costs or deletes to the stipulated lump sum contract price are subject to review and scrutiny by a qualified third party or individual.
- 1.37.10. The material costs used shall be a discount to nationally available pricing guides (i.e. Trade Service, Allpricer, etc.) to reflect a value with a fair and reasonable markup to the actual cost of the materials purchased from distributors. The Owner and/or Engineer's Representative reserve the right to negotiate material pricing to a value that is fair and reasonable to the Owner.
- 1.37.11. Labour Rate
- .1 During the duration of the electrical contract, extra work hourly labour units are to be based on the latest edition of the National Electrical Contractors Association (NECA) labour units column 1(one). No additional factors will be accepted.
 - .2 The hourly labour rate for all changes will be based on a Journeyman Electrician rate as listed on the Bid Form and/or Electrical Supplementary Bid Form. The Owner and/or Engineer's Representative reserve the right to renegotiate the labour rate. The hourly labour rate will be inclusive of overhead, markup and profit. The labour rate will be inclusive of all labour burden charges as stated in this 'Valuation of Changes' section above.
 - .3 The following labour burdens are not part of the hourly labour cost, but are covered under the NECA labour unit rates: safety measures and regulations; drawing and specification study; layout, measuring and marking the installation location; material unloading, jobsite storage and delivery to the installation area; inspection, uncrating and shipping support removal; tool acquisition and return to storage; clean-up of excess material; and testing circuits for continuity.
 - .4 At the request of the Owner or the Engineer's Representative, the Contractor is to submit a detailed labour cost breakdown showing a breakdown of all adders to the base wage rate to show how the Contractor has come to the proposed hourly rate. The Owner and the Engineer's Representative reserve the right to negotiate the hourly labour rate with the Contractor.
 - .1 Provide detailed labour cost breakdown for both foreman and journeyman, including the categories shown below, with each category expanded to show the individual line items within the category:
 - .1 Category: Wages
 - .1 Base rate
 - .2 Vacation / Statutory Holiday pay
 - .3 xxx
 - .2 Category: Union / Association Funds
 - .1 xxx
 - .3 Category: Payroll Burdens
 - .1 EI
 - .2 CPP
 - .3 xxx
 - .4 Category: Labour Burdens
 - .1 xxx

- 1.37.12. When pricing additional work for Proposed Changes, the Electrical Contractor shall only price new materials that are required for the Proposed Change. Where existing materials and/or infrastructure (i.e. homerun conduits back to electrical panels) can be re-used for the Proposed Change, the Electrical Contractor shall utilize these items in the valuation of the Change at no extra cost.
- 1.37.13. Where a Proposed Change includes both credits and extras, overhead and permitted mark-ups apply to the net extra or credits, if any, of the entire change.
- 1.37.14. When pricing Proposed Changes containing both additions and credits, and where no work and/or materials have been installed on site, the Electrical Contractor shall only price the net new materials and net new labour that are required for the Proposed Change. Per unit labour and material costs shall be equal for credits and additions.

PROPOSED CHANGE ORDER

Company Name:	CCN #
Address:	Date:
City, Prov.:	Project Name:
Postal Code:	Project Number:
	Page Number:
Telephone:	Change Order #:
Fax:	
E-Mail address:	

Client Address:

Work Description

We reserve the right to correct this quote for errors and omissions.
This quote covers direct costs only.
This price is good for acceptance within 30 days from the date of receipt.

Itemized Breakdown

Description	Qty	Net Price U	Total Mat(\$)	Labor U	Total Hours
3/4" EMT		xxx.xx C		5.00 C	
3/4" EMT STL SS CONN		xx.xx C		10.00C	
3/4" EMT STL SS CPLG		xx.xx C		5.00 C	
3/4" EMT STRAP 1-H		xx.xx C		4.00 C	
#10 x 1" SELF TAPPING SCREW		x.xx C		5.50 C	

TOTALS

Description

Material

General Materials

Permitted Mark-up (@ xx.xx %)

Material Total

Labour

Journeyman (xx Hrs. @ \$xx.00)

Foreman @ 10% (xx Hrs. @ \$xx.00)

Labour Total

Material and Labour Total

Final Amount

1.38. DEMOLITION

- 1.38.1. The demolition drawings show the general scope of the demolition and not exact details or total extent. For exact details and total extent each service must be carefully checked on site. Before removing services follow the service through to ensure other areas of the building are not affected.
- 1.38.2. Whenever existing services or equipment are to be removed, all electrical connections for such services shall be removed and securely terminated in an approved manner. If necessary to facilitate installation of new work, any existing services and equipment shall be removed and then replaced by this division.
- 1.38.3. Whenever it becomes necessary to relocate any electrical services equipment to make possible installation of the work under this contract, such relocation shall be done by this division without additional cost to the Owner.
- 1.38.4. Make safe and disconnect all power and systems, as and when, and to the extent required to facilitate the demolition.
- 1.38.5. If applicable, review the mechanical, architectural, and other related discipline drawings, and include for removing and making safe all power connections to demolished equipment and devices, back to the source panel, except where indicated otherwise on the drawings.
- 1.38.6. Ensure that all electrical, life safety services, and services for existing equipment, in areas outside the areas of this work, that are required to remain in service, shall do so.
- 1.38.7. Relocate any electrical feeders or equipment that are required to remain in service, that are secured to existing walls, floors or ceilings to be demolished or that are buried and required to be excavated for new work.
- 1.38.8. Remove and replace any electrical equipment on walls or ceilings that will be demolished and rebuilt.
- 1.38.9. Disconnect and remove existing light fixtures, devices, outlets, CCTV, security devices, etc. which are not to be reused. Such items shall be packaged and turned over to the Owner at a place designated by the Owner. Cut back and cap unused raceway and outlets and remove unused wiring back to panelboard in an approved manner.
- 1.38.10. Ensure that all existing equipment which is to be reused and/or relocated is thoroughly reviewed and refurbished to ensure correct operation when put back into service and to meet the requirements of the local authorities having jurisdiction. All existing electrical equipment which is no longer required shall be removed and disposed of off-site.
- 1.38.11. Carry out the work with a minimum of noise, dust and disturbance.
- 1.38.12. Provide tools and clean up equipment. Obtain the Owner's permission for the use of electrical, plumbing or drainage outlets.
- 1.38.13. Where a device is shown to be relocated on the drawings, contractor to remove and re-install device and back box and re-feed the device with new conduit and wire from the nearest existing accessible junction box.
- 1.38.14. Electrical Contractor is responsible for the patching and re-painting the entire wall where a device and/or box has been added, removed or relocated.

1.39. CYBER SECURITY

- 1.39.1. Coordinate with Owner's Information Technology representatives, obtain a copy of Owner's cyber security policy and provide all applicable cyber security configurations.
- 1.39.2. Definitions
 - .1 Cyber Assets: Systems (including hardware, software, and data) and communication networks (including hardware, software, and data).

- .2 Critical Cyber Assets: Cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.
 - .3 Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.
 - .4 Cybercrime: Any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.
 - .5 Cyber Hygiene: Practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.
 - .6 Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.
 - .7 Cyber Security: Technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.
 - .8 Cyber Threat or Cyber Security Threat: Malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS / DoS) attacks and other attack vectors.
 - .9 Cyber Threat Actors: Broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber Security awareness, and technological developments to gain unauthorized access to information systems in order to access or otherwise affect victims' data, devices, systems and networks.
 - .10 IP Multicast: Technique for one-to-many and many-to-many real-time communication over an IP Infrastructure network.
 - .11 Endpoint: Remote computing device that communicates back and forth with a network to which it is connected. Such as a server, desktop, or laptop.
 - .12 Network Certificates: Also known as a Digital Certificates, which are an electronic "password" that allows a person or organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:
 - .1 Secure Socket Layer Certificate (SSL) Digi-SSL
 - .2 Software Signing (Code Signing Certificate) Digi-Code
 - .3 Client Certificate (Digital ID) Digi-ID
 - .13 Social Engineering: Exploitation methods that target human vulnerabilities, such as carelessness and trust.
 - .14 Technical Vulnerabilities: Weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.
- 1.39.3. Cyber Security Measures
- .1 Implement at minimum the following multi-layered Cyber Security measures to limit and / or reduce the Owner's potential risk from a cyber threat event; such as a Cyber Security data breach or Cyber Security attack.
 - .2 Password Management
 - .1 Employ password management best practices such as:
 - .1 Do not use default passwords.

- .2 Use strong and unique passwords for all applications. Use a minimum of 8 characters where there is no password policy inherent in the software; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ?]).
- .3 Reset passwords at regular intervals.
- .4 Configure two-factor authentication for all accounts where possible in the system software.
- .5 Do not use System Admin logins for simple tasks; create separate User accounts with rights levels appropriate for the job function. Create and define user accounts as appropriate such as Role based, Individual logins or assigned roles.
- .6 Use different passwords for every account.
- .7 Enforce secure password policies within the business environment.
- .8 Have interface lock after a predefined # of failed login attempts for a pre determined time interval.
- .3 Port and Interface Management
 - .1 Employ Port Management techniques such as:
 - .1 Restrict access on network switch ports to assigned devices addresses.
 - .2 Lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.
 - .3 Shut off all unused communication services and hardware interfaces.
 - .4 Advise Owner on use of 3rd party port security monitoring.
- .4 Physical and Virtual Networks
 - .1 Provide a dedicated VLAN for network connected systems where a dedicated LAN has not been provided.
- .5 Encryption
 - .1 Use minimum TLS 1.2 for all network attached equipment and use TLS 1.3 where available.
- .6 Network Certificates
 - .1 Ensure Network Certificates are up to date and not expired for all equipment and systems.
- .7 Firmware & Software Update Management
 - .1 Use the latest stable Firmware / Software version on all devices / equipment as well as implement a Firmware / Software Update management process and procedure.
- .8 Manufacturer's System Hardening Guides
 - .1 Provide the Manufacturer's System hardening guides for the equipment being installed and implement as many recommendations / features as possible.
- .9 External Memory
 - .1 Restrict the use of external memory. Restrict or eliminate the use of devices such as external USB Thumb drives unless expressly allowed by the Owner's Information Technology representatives.
- .10 Log Off
 - .1 Enable auto-log off timer for all software, websites and logins. Set auto-log off timer on local Workstation(s) being used to access the equipment with a

reasonable timer in the case that an employee leaves the workstation unattended.

.11 Anti-Virus Software

- .1 Enable and configure anti-virus software on PC endpoints in accordance with the Owner's Information Technology requirements, unless it is to be installed and configured by the Owner.

.12 Filtering Techniques

- .1 Apply filtering techniques including the types listed below where possible:
 - .1 Web Filtering: A Web filter adds another layer to anti-phishing defences by blocking the web based component of phishing and malware attacks.
 - .2 Multicast Message Filtering: Filters the packets sent to multicast groups users are not subscribed to.
 - .3 Content Filtering: Is the use of a program to screen and / or exclude access to web pages or email deemed objectionable. A content filter will then block access to this content.

.13 Back up Regularly

1. Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible.
2. Identify files that require manual backup and the backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.

1.39.4. IT Devices and Systems

- .1 Apply the Cyber security measures listed in the clauses above in part or in full, as possible, to a wide range of Information Technology (IT) Devices including:
 - .1 Firewalls
 - .2 Routers
 - .3 Network switches (Core and Edge Devices)
 - .4 Servers and databases
 - .5 Workstation computers
 - .6 Network connected system devices and controllers
 - .7 Wireless Access Points and wireless controllers
 - .8 Mobile phones and tablets
 - .9 Any IT System or endpoint connected to the network

1.39.5. Operational Technology (OT) Devices and Systems

- .1 Apply the Cyber security measures listed in the clauses above, in part or in full, as possible, to a wide range of OT Network devices including:
 - .1 Industrial Control Systems such as:
 - .1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.
 - .2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.

- .3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.
 - .4 (CNC) Computer numerical Control is the automated control of machining tools (Drills, boring tools, lathes) and 3D printers by means of a computer.
 - .2 Building Management Systems (BMS) and Building Automation Systems (BAS)
 - .3 HVAC equipment
 - .4 Lighting controls for both internal and external applications
 - .5 Energy monitoring and metering equipment
 - .6 Transportation and parking systems
 - .7 Scientific equipment
 - .8 Any other OT System or endpoint that can be connected to the network
 - 1.39.6. Report Cybercrime
 - .1 Advise the Owner and / or their representatives of any indication of a Cyber Incident of a criminal nature when performing any work on a network connected system.
 - 1.39.7. Cyber Security Report Letter
 - .1 Provide a Cyber Security Report Letter in the closeout documents to the client stating which Cyber Security measures have been implemented, when implementing any and / or all of the Cyber Security Measures mentioned in this Specification.
 - 2. Products
 - 2.1. NOT USED
 - 3. Execution
 - 3.1. NOT USED
- END OF SECTION

26 05 03.00 As-Built Drawings

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Refer to As-built Drawings in Section 01 70 00 (01 72 29.00) – CLOSEOUT SUBMITTALS.

1.3. RECORD OF REVISIONS ON SITE

1.3.1. Maintain an updated copy of plans and schematics in the digital format for which the project is provided (i.e. AutoCAD or Autodesk Revit MEP) and be capable to produce documents in Adobe PDF upon request.

2. Products

2.1. AS-BUILT DRAWINGS

2.1.1. Request in writing from the Engineer's Representative all electrical Revit drawings. Complete release form provided by Engineer's Representative and pay the Engineer's Representative directly the costs identified in this section below prior to receiving the drawings. After the final as-built drawings have been reviewed, send the Engineer's Representative a copy via electronic transfer for their records and send a minimum of one copy on USB key with each set of maintenance manuals. Provide additional copies if required under the General Conditions. Use the same version of Revit software that the model was created in and provide electronic files saved in a version acceptable to the end user and engineer.

2.1.2. The contractor is to identify the cost of As-Built Drawings and the Operation and Maintenance Manuals as a separate line item on their progress draw. The following values are to be broken out:

\$5,000	For Electrical Contracts up to \$250,000
2% of Electrical Contract	For Electrical Contracts from \$250,000 to \$1,500,000
\$30,000	For Electrical Contracts over \$1,500,000

2.1.3. The project will remain incomplete and no money will be released until the final versions, both hard and electronic, of the drawings and manuals are received.

2.1.4. Final as-built prints/plots shall not contain markings or corrections by hand (i.e. marker, pen, pencil, etc.). References to the Architect and Engineer must be deleted from the drawings.

2.1.5. Final as-built drawings to include all revisions made to the drawings during construction, including all approved changes. The as-built drawings are to also include the routing of all feeders except for branch circuits, all junction boxes to be shown, drawing legend to be updated to include all symbols and lines used to show as-built conditions, quantity of wires in each conduit, and circuit numbers of wires in each conduit. Include slab layout drawings in as-built drawing package.

2.1.6. CADD Requirements.

- .1 A complete list of layer names and brief description of each layer's use shall accompany all files.
 - .2 Fonts for text shall be Autodesk standard. Custom fonts, shape files, etc., are not to be used.
 - .3 Final as-built drawings shall be returned on USB stick.
 - .4 Each USB stick shall include a file containing Engineer's Representative and Owner, Contract number, file names and Drawing number. Provide a "readme.txt" file in ASCII format. A printed copy of the readme file shall accompany each USB stick.
 - .5 All drawings shall be in the same units as issued on Bid Documents.
 - .6 Provide a complete list of symbol (block) names with a description of each symbol.
 - .7 Special effort shall be made to ensure that drafting is accurate: i.e. appropriate lines are indeed horizontal and vertical; lines that should intersect do but not over-intersect and ensure that entities are placed on correct layers.
- 2.1.7. Maintain records on site, as the job progresses, and record all changes and deviations from that shown on Contract Drawings. After review and approval of service lines in trenches, take "as-built" measurements, including all depths, prior to commencement of backfilling operations. Show the location of buried electrical ducts and conductors on the drawings and dimensioned from fixed points. Keep drawings up-to-date during construction and in addition to field measurements include Change Orders, Supplemental Instructions and all other changes.
- 2.1.8. On completion of the building, forward to the Engineer's Representative the digital drawings indicating all such changes and deviations for review by the Engineer's Representative.
- 2.1.9. If required, the Engineer's Representative will provide a quotation to this Contractor to transfer "As-Built" information from the mark-up documentation to the acceptable software.
- .1 Include a cost of \$400.00 per sheet for the transfer of marked up "As Built" information to Autodesk Revit MEP and forwarding of the electrical information by the Engineer's Representative to the Owner.
- 2.1.10. The Electrical Contractor may request from the Engineer's Representative the most current electronic documentation (Electrical Drawings) in Autodesk Revit MEP sent via electronic transfer. The Engineer's Representative will provide the Drawings one time at no charge. Where the Drawings are requested more than one time throughout the course of the project, a nominal charge of \$1,000.00 will apply to the second and subsequent requests.
- 2.1.11. The Autodesk Revit MEP as-built documents shall meet all the Owner's and Engineer's Representative's requirements.
3. Execution
- 3.1. NOT USED

END OF SECTION

26 05 04.00 Submittals/Shop Drawings

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. RELATED WORK

1.2.1. Comply with Div. 00 for submittal requirements and as amended below.

2. Products

2.1. SHOP DRAWINGS

2.1.1. Shop Drawings shall be organized by Specification Section. Ensure shop drawing package for a given Specification Section is complete, including all equipment, products, materials, and systems to be used as part of that Specification Section, and submit as a single shop drawing package. Do not submit numerous separate shop drawings for the same Specification Section. Do not combine more than one section into one submission. Incorrect submissions will be returned without review.

2.1.2. Submittals/Shop Drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each Shop Drawing shall give the identifying number of the specific assembly for which it was prepared (e.g. SWBD-1A).

2.1.3. Submit shop drawings electronically, by email, in PDF format. Submissions that are not electronic without prior approval from the Engineer's Representative shall be returned as not reviewed. Provide the following information in the email submission:

- .1 S+A project number and Contractor Shop Drawing Identifier in Subject Line
- .2 Attachments shall be limited to 10 MB
- .3 Provide FTP hyperlink for all attachments in excess of 10 MB with appropriate information for downloading the file (as required)
- .4 Shop Drawing Submission to the following email address:
 - .1 ContractAdmin.Toronto@smithandandersen.com

2.1.4. Shop drawings submitted directly to Smith + Andersen personnel (and not copied to the email address provided above) without advanced permission will not be processed nor considered as received.

2.1.5. Each Shop Drawing for non-catalogue items shall be prepared specifically for this project. Shop Drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.

2.1.6. When requested, Shop Drawings shall be supplemented by data explaining the theory of operation – for example: lighting control sequence of operation – the Engineer's Representative may also request that this information be added to the maintenance and operating manual.

2.1.7. Provide a cover sheet with the project name, issue date, issue number, specification section number, and title of section with space for Shop Drawing review stamps for the Contractor and Engineer's Representative.

2.2. ENVIRONMENTAL PRODUCT DECLARATIONS (EPD)

- 2.2.1. Where EPDs are available for Products, submit them for review.
- 2.2.2. Follow Product Category Rules (PCRs) for Life Cycle Assessment (LCA) presented on EPDs.
- 2.2.3. Where multiple EPDs are available for the same Product, the order of preference is as follows:
 - .1 Product Specific, Facility Specific EPD: a Product and manufacturer specific EPD, where the environmental impacts are unique to the specific manufacturing facility.
 - .2 Product Specific EPD: a Product and manufacturer specific EPD where the environmental impacts are considered across multiple manufacturing facilities (i.e. an average of the different facilities in which the Product is manufactured).
 - .3 Industry Average EPD: an EPD for a type of Product, representing the typical environmental impacts averaged across a number of different manufacturers.

3. Execution

3.1. SUBMISSION

- 3.1.1. Each Shop Drawing or catalogue sheet shall be in original PDF format stamped and signed by the Contractor to indicate that they have checked the drawing for conformance with all requirements of the Drawings and Specifications, that they have co-ordinated this equipment with other equipment to which it is attached and/or connected and that they have verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the Work of other trades. Ensure that electrical and mechanical co-ordination is complete before submitting drawings for review.
- 3.1.2. Scanned PDF versions are not acceptable.
- 3.1.3. Equipment shall not be released for manufacture until the shop drawing has been reviewed by Engineer's Representative. Contractor shall assume responsibility and cost for field changes. Installation of any equipment shall not start until after final review of Shop Drawings by the Engineer's Representative has been obtained.
- 3.1.4. Should equipment or materials that arrive on site differ from those shown on the Shop Drawings, bear all costs for:
 - .1 Revising the equipment and materials.
 - .2 Revising the Work of other contractors impacted.
- 3.1.5. As part of the electrical Engineer's Representative's scope of the work, shop drawings shall be reviewed no more than twice. Should three or more reviews be required due to reasons of Contractor omissions causing resubmission requests, the Contractor shall reimburse the electrical Engineer's Representative for time expended in these extra reviews.

END OF SECTION

26 05 05.00 Mounting Heights

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. NOT USED

3. Execution

3.1. MOUNTING HEIGHTS

3.1.1. Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

3.1.2. If mounting height of equipment is not specified or indicated, verify with the Consultant before proceeding with installation.

3.1.3. Unless indicated otherwise on the drawings or within the specifications, install electrical equipment at following heights.

.1 Local switches: 1050 mm.

.2 Wall receptacles:

.1 General: 450 mm.

.2 Above top of continuous baseboard heater: 200 mm.

.3 Above top of counters or counter splash backs: 175 mm.

.1 Where these receptacles are located adjacent to and in close proximity to local switches, mount receptacles at the same elevation as the local switches to provide a neat, aligned, installation.

.4 In mechanical rooms: 1200 mm.

.5 In equipment storage rooms: 900 mm.

.3 Receptacles for maintenance of equipment located on rooftops:

.1 Not less than 750 mm above the finished roof, per Electrical Code.

.4 Panelboards: 2000 mm to top of panel.

.5 Telephone and interphone outlets: 450 mm.

.6 Wall mounted telephone and interphone outlets: 1050 mm.

.7 Fire alarm stations: 1200 mm, measured to the top of the manual pull station.

.8 Wall Mounted Fire alarm audible devices: 2300 mm and not less than 150 mm from the ceiling, measured to the top of the device.

.9 Television outlets not mounted behind a wall mounted television: 450 mm.

.10 Wall mounted speakers: 2100 mm.

.11 Clocks: 2100 mm.

- .12 Power Door Operator push buttons: 1050 mm.
- .13 Wall mounted Exit Signs
 - .1 For 2400 mm to 2500 mm ceiling heights: 2100 mm.
 - .2 For all ceilings heights greater than 2500 mm: 2400 mm.
- .14 Wall mounted Battery Packs and Emergency Heads
 - .1 For 2400 mm to 2500 mm ceiling heights: 2100 mm.
 - .2 For all ceilings heights greater than 2500 mm: 2400 mm.
- .15 Wall mounted occupancy sensors: 1050 mm.
- .16 Wall mounted visible signal devices: 2100 mm to centre of lens; or as allowed by CAN/ULC-S524 "Standard for Installation of Fire Alarm Systems" except where facility accessibility standards require otherwise.
- .17 Top of remote annunciator and passive graphic panels shall be no more than 1800 mm above finished floor.
- .18 Wall mounted emergency telephone (Fireman's Handset): 1350 to 1500 mm.

END OF SECTION

26 05 21.00 Wires and Cables Under 2000 V

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.

1.2. REFERENCES

- 1.2.1. CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables, latest edition.
- 1.2.2. CSA C22.2 No. 38, Thermoset-Insulated Wires and Cables, latest edition.
- 1.2.3. CSA C22.2 No. 51, Armoured Cables, latest edition.
- 1.2.4. CSA C22.2 No. 75, Thermoplastic-Insulated Wires and Cables, latest edition.
- 1.2.5. CSA C22.2 No. 96, Portable Power Cables, latest edition.
- 1.2.6. CSA C22.2 No. 123, Metal Sheathed Cables, latest edition.
- 1.2.7. CSA C22.2 No. 124, Mineral-Insulated Cable, latest edition.
- 1.2.8. CSA C22.2 No. 131, Type TECK 90 Cable, latest edition.
- 1.2.9. CSA C22.2 No. 174, Cables and Cable Glands for Use in Hazardous Locations, latest edition.
- 1.2.10. CAN/ULC S139 / UL 2196 (Binational Standard), Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables, latest edition.
- 1.2.11. ASTM B800 - Standard Specification for 8000 Series Aluminium Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4. WARRANTY

- 1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. BUILDING WIRES

- 2.1.1. Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- 2.1.2. Contractor to provide copper conductors on conductors sizes up to and including #8 AWG. Contractor to provide copper conductors for sizes larger than #8 AWG unless identified as aluminium or NUAL on the drawings.
- 2.1.3. All conductors to have size as indicated, with insulation of chemically cross-linked thermosetting polyethylene material rated RW90 or RWU90 to CSA C22.2 No. 38 rated as follows:

- .1 Insulation rated at 1000 V for 600 V systems that are ungrounded or have a neutral grounding resistor to limit ground fault current.
 - .2 Insulation rated at 600 V for the other 600 V and 347/600 V distribution systems not covered under item #1 above.
 - .3 Insulation rated at 600 V for all systems rated at 480 V and less.
- 2.1.4. All aluminium or NUAL conductors to be an aluminium alloy with CSA certified as an Aluminium conductor material (ACM) and meet the requirements of the Aluminium Association Inc. AA8030 and ASTM B800 standards. Provide an anti-oxidant compound, Ideal NOALOX, on all aluminum conductor terminations.
- 2.1.5. RWU90 wiring is to be used for underground installations.
- 2.2. TECK CABLE
- 2.2.1. Cables to CSA C22.2 No.131.
- 2.2.2. Conductors:
- .1 Bonding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
- 2.2.3. Insulation:
- .1 Chemically cross-linked thermosetting polyethylene type RW90, rated 1000 V.
- 2.2.4. Inner jacket: polyvinyl chloride material.
- 2.2.5. Armour: interlocking aluminum.
- 2.2.6. Overall covering: thermoplastic polyvinyl chloride material rated at a minimum of FT-4.
- 2.3. VARIABLE FREQUENCY DRIVE CABLES
- 2.3.1. Variable frequency drives are also known as variable speed drives.
- 2.3.2. Cables to CSA C22.2 No. 123 or No. 131, and to CSA C22.2 No. 174.
- 2.3.3. Conductors:
- .1 Three (3) bare copper bonding conductor sized to Table 16 of the electrical code.
 - .2 Circuit conductors: copper, size as indicated on Drawings.
 - .3 Profile of VFD Cable cross section shall be entirely symmetrical.
- 2.3.4. Shield: Flat copper tape shield, or continuously corrugated and welded aluminum sheath, depending on cable construction.
- 2.3.5. Insulation:
- .1 Chemically cross-linked thermosetting polyethylene (XLPE) with high dielectric strength to withstand repetitive high voltage spikes of 3.1 times the nominal system voltage rating due to VFD IGBT output.
 - .2 Type RW90 or RWU90 CSA rated for 1000 V, and suitable for voltage spikes mentioned in .1 above.
- 2.3.6. Where compliant with CSA C22.2 No. 123, Armour: continuously corrugated and welded aluminum.
- 2.3.7. Where compliant with CSA C22.2 No. 131, Inner jacket: polyvinyl chloride material.
- 2.3.8. Where complaint with CSA C22.2 No. 131, Armour: interlocking aluminum.
- 2.3.9. Overall covering: thermoplastic polyvinyl chloride (PVC) material rated at a minimum of FT-4.

- 2.3.10. Cable to be complete with manufacturer's cable termination kits including terminating connectors for proper termination of shield to ground. Termination kits to ensure common mode stray currents are drawn away from the motor to extend motor life-span. Termination kits to include self-terminating connectors that provide 360 degree contact to the shield / sheath.
- 2.4. MINERAL-INSULATED CABLES
- 2.4.1. Conductors: solid bare soft-annealed copper, size as indicated.
- 2.4.2. Insulation: compressed powdered magnesium oxide to form compact homogeneous mass throughout entire length of cable.
- 2.4.3. Overall covering: annealed seamless copper sheath, Type M1 rated 600 V, 250 C.
- 2.4.4. Outer jacket: PVC applied over sheath, where installed in damp and wet locations.
- 2.4.5. Two (2) hour fire rating.
- 2.4.6. Conform to requirements of CSA C22.2 No. 124; and CAN/ULC S139.
- 2.4.7. All mineral-insulated cable larger than #6 AWG shall be single conductor. For conductors #6 AWG and smaller, multi-conductor mineral-insulated cable is acceptable.
- 2.4.8. Manufacturer / Product: nVent Pyrotenax System 1850.
- 2.5. FIRE RATED TYPE RC CABLE
- 2.5.1. Conductors: stranded annealed copper, size as indicated.
- 2.5.2. Insulation: low smoke silicon rubber.
- 2.5.3. Armour: continuously welded and corrugated copper sheath.
- 2.5.4. Outer Jacket: Provide black low smoke, zero halogen polyolefin, FT4 rated where installed in damp and wet locations.
- 2.5.5. Two (2) hour fire rating.
- 2.5.6. Conform to requirements of CSA C22.2 No. 123; and CAN/ULC S139 with hose stream.
- 2.5.7. Manufacturer / Product:
- .1 Prysmian Draka Lifeline Type RC90.
- .2 Berkshire Hathaway Marmon RSCC VITALink Type RC90.
- 2.6. ARMOURED CABLES
- 2.6.1. Cables to: CSA C22.2 No. 51.
- 2.6.2. Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
- 2.6.3. Type: AC90 (BX).
- 2.6.4. Armour: interlocking type fabricated from aluminium strip.
- 2.6.5. Type: ACWU90 - PVC flame retardant jacket over armour meeting requirements of Vertical Tray Fire Test of CSA C22.2 No. 0.3 with maximum flame travel of 1.2 m.
- 2.7. ALUMINUM SHEATHED CABLE
- 2.7.1. Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
- 2.7.2. Insulation: type RA90 rated 1000 V.

- 2.7.3. Sheath: aluminium applied to form continuous corrugated seamless sheath.
- 2.7.4. Outer jacket of PVC applied over sheath for direct burial or wet locations.
- 2.8. DIESEL LOCOMOTIVE CABLES (DLO)
 - 2.8.1. Cable: to CSA C22.2 No. 96 Portable Power Cables, rated to 2000 V.
 - 2.8.2. Conductor: stranded tinned annealed copper, size and number as indicated
 - 2.8.3. Separator: paper or polyester tape separates the conductor from the rubber insulation to aid in stripping.
 - 2.8.4. Insulation: premium grade Ethylene Propylene Rubber (EPR), rated 90 deg. C.
 - 2.8.5. Jacket: black, heavy duty chlorinated polyethylene (CPE), sunlight resistant, rated at a minimum of FT-4.
- 2.9. WIRING TERMINATION
 - 2.9.1. Lugs, terminals, screws used for termination of wiring to be to be dual rated for Copper/Aluminum (Cu/Al).
 - 2.9.2. Lugs, terminals, and screws used for termination of multiple wires must be rated for their intended use.
 - 2.9.3. For lugs used in connecting power utility company equipment or services, provide lugs that have CSA Die Index stamped on lug to facilitate proper crimping.
- 3. Execution
 - 3.1. GENERAL
 - 3.1.1. Provide a minimum of one bonding conductor for each three ungrounded conductors on all cable runs that do not include conduit. Provide a minimum of one bonding conductor within each power conduit.
 - 3.1.2. For all bonding conductors, provide copper conductors insulated with a green coloured insulation.
 - 3.1.3. Provide a separate dedicated insulated bonding conductor for isolated ground receptacles. See detail on Drawings for more information.
 - 3.1.4. Provide a dedicated neutral for GFCI and AFCI breaker circuits. Install in accordance with breaker manufacturer's written instructions.
 - 3.1.5. Size bonding conductor to applicable tables of the:
 - .1 Ontario Electrical Safety Code.
 - 3.1.6. All equipment, junction boxes, pull boxes, liquid tight flex, etc. to be bonded to ground through bonding conductors.
 - 3.1.7. Provide separate neutral conductor for each 120 volt circuit for all circuits feeding receptacles and power outlets.
 - 3.1.8. Do not install cables or devices on the surface of, or within 100 mm of the underside of roof decks.
 - 3.1.9. Ensure slack is provided in wiring connections to equipment which contains moving parts.
 - 3.1.10. Provide a variable frequency drive (VFD) cable from each VFD unit to each motor. Wiring to be installed in accordance with the VFD and motor manufacturer instructions.

- 3.1.11. Utilize compression type fittings for the following terminations: incoming conductors into main lug only panelboards rated over 600 A; and terminations onto bus work in switchboards, switchgear, transformers, transfer switches, generators, UPSs, and other electrical equipment.
- .1 For all compression type fittings, provide two-hole long barrel type lugs complete with lug inspection / viewing windows that allow installer to see how far the conductor has been inserted into the lug. Where mechanical screw type lugs are allowed, ensure that they are suitable for the quantity of parallel runs of wire that are to be terminated under. Provide lugs that are dual rated for copper (Cu) and aluminum (Al).
- 3.1.12. Armoured Cable Type AC90 (BX) may only be used for individual drops from slab mounted junction box to recessed mounted light fixtures or where noted on the drawings where wiring is required to be installed within an existing wall. The maximum allowable distance of armoured cable is 3 m. Contractor to receive written approval from the Engineer's Representative to run armoured cable further than 3 m from junction box. Daisy chaining of fixtures is only acceptable in dry wall ceilings. Wiring in conduit is to be brought to a junction box to allow for the transition to armoured cable. Armoured cable is not to be installed directly into electrical panels or run in walls for receptacles.
- 3.1.13. Branch circuit wiring to be upsized as follows to address voltage drop when:
- .1 The entire length of the circuit wiring exceeds 25 m – branch wiring to be a minimum of No. 10 AWG.
- .2 The entire length of the circuit wiring exceeds 40 m – branch wiring to be a minimum of No. 8 AWG.
- .3 The entire length of the circuit wiring exceeds 60 m – branch wiring to be a minimum of No. 6 AWG.
- 3.1.14. Where feeders or branch circuits are run underground, upsize conductors to comply with the requirements of electrical code Rule 4-004, Ampacity of wires and cables, using Diagrams D8 to D11 and Tables D8A to D11B of the electrical code. Where conductors are upsized due to Tables D8A to D11B, upsize conduits to comply with the requirements of electrical code Rule 12-910, Conductors and cables in conduit and tubing.
- 3.1.15. Where one (1) hour or two (2) hour conductor fire rating is indicated on the Drawings, provide fire rated Mineral-Insulated cables or fire rated MC cables. Fire rated Mineral-Insulated and MC cables shall be installed in accordance with the manufacturer's installation instructions and the fire rated cable product listing in order to maintain their fire rating. Special attention shall be paid to cable supporting method and fire rating of the structure from which the cables are supported.
- 3.1.16. Where conductors supply power to emergency lighting and the emergency lights are located on a different floor level than the power source (i.e. panel), then the conductors shall be fire rated for at minimum one (1) hour using fire rated Mineral-Insulated cables. Conductors with two (2) hour fire rating shall be used where indicated on Drawings. Provide fire rated Mineral-Insulated cables or fire rated MC cables where conductors require fire ratings.
- 3.1.17. Where alternatives to fire rated cables are indicated on the Drawings, such as running conduits within concrete cast in place slabs, under concrete slabs on grade, or within fire rated shaft/riser, care must be taken to ensure that the required fire rating is maintained. Where drawings call for conduits to be run within concrete cast in place slabs, the slabs must be of sufficient thickness to achieve the required fire rating and be no less than 51 mm (2 in.) of concrete cover both above and below conduits where one (1) hour fire rating is required and 102 mm (4 in.) concrete cover both above and below conduits where two (2) hour fire rating is required. The contractor shall submit a letter confirming the concrete coverage or construction of fire rated assembly provides the sufficient fire rating of the enclosed conduits.
- 3.1.18. Wire Splicing

- .1 Splice up to and including No. 6 AWG with nylon insulated expandable spring type connectors.
- .2 Splice larger conductors using compression type connectors wrapped in PVC insulation rated at the respective voltage.

3.2. INSTALLATION OF BUILDING WIRES

- 3.2.1. Install all building wiring in conduit unless otherwise noted. Conduit to be sized to the electrical code unless noted on the drawings or in the specifications.
- 3.2.2. All conductors are to be colour coded. Provide colour tape at all terminations to identify all conductors in each run.

3.3. INSTALLATION OF TECK 90 CABLE, VARIABLE FREQUENCY DRIVE CABLE, ARMoured CABLE OR ALUMINUM SHEATHED CABLE

- 3.3.1. Group cables wherever possible on channels.
- 3.3.2. Terminate cables in accordance with manufacturer's installation instructions.
- 3.3.3. Fastenings:
 - .1 One-hole steel straps to secure surface cables 53 mm and smaller. Two-hole steel straps for cables larger than 53 mm.
 - .2 Channel type supports for two or more cables.
 - .3 Galvanized threaded rods: 6 mm diameter minimum to support suspended channels.
 - .4 Pre-engineered support systems complying with CSA C22.2 No. 18.4 "Hardware for the support of conduit, tubing, and cable (Bi-national standard with UL 2239)."
- 3.3.4. Connectors:
 - .1 Watertight, approved for respective cables.
- 3.3.5. For single conductor cables, ground the sheath at the upstream (source) panel and provide insulated fibre plate at the load end, so as to prevent circulating sheath currents.
- 3.3.6. Where TECK 90 cable is run through or passes through a plenum space, install TECK 90 cable in conduit and comply with electrical code conduit fill percentage rules.

3.4. INSTALLATION OF MINERAL-INSULATED CABLE SYSTEM AND FIRE RATED TYPE RC CABLE SYSTEM

- 3.4.1. General:
 - .1 Comply with: the requirements of the manufacturer's UL listing for the fire rated cable system and the manufacturer's written installation instructions.
 - .2 Provide all Products required by the manufacturer's UL listing to provide a fully certified system.
- 3.4.2. Handling:
 - .1 Cable shall be uncoiled by rolling or rotating supply reel. Do not pull from coil periphery or centre.
- 3.4.3. Splicing:
 - .1 Make all fire rated splices in the factory. In the event that a field splice is necessary, have the manufacturer's field technician make it in the field.
- 3.4.4. Terminations:

- .1 Make field made terminations using the cable manufacturer's termination kits. Use stripping tools, crimping tools and compression tools, available from the manufacturer for proper cable termination.
 - .2 Connections to ferrous cabinets for single conductor cables shall incorporate brass plates. Install per manufacturer's drawing.
 - .3 At cable terminations, use thermoplastic sleeving over bare conductors.
- 3.4.5. Sheath induction reduction:
- .1 When multi-phase circuits have paralleled single conductors, run cables in groups having one of each phase in each group.
 - .2 Separate each set of paralleled conductors by at least two single cable diameters.
- 3.4.6. Exposed or Surface Installations:
- .1 Secure cable(s) to the fire rated building structure using:
 - .1 Supporting methods outlined in the manufacturer's UL listing for the fire rated system utilized.
 - .2 Support fire rated cables at the intervals required by the manufacturer's UL listing.
- 3.4.7. Wall or floor penetrations:
- .1 Provide approved fire stopping of all penetrations.
 - .2 Neatly train and lace cable inside boxes, equipment, and panelboards.
 - .3 Where cables are buried in cast concrete or masonry, sleeve for entry of cables.
 - .4 When penetrating a fire rated wall or fire rated floor, the cable must extend a minimum of 305 mm beyond the fire rated wall or fire rated floor. The 305 mm dimension can be in any direction as 305 mm of cable length is required to allow for proper heat dissipation such that cable terminations do not overheat.
- 3.5. FIELD QUALITY CONTROL
- 3.5.1. Prior to energizing wires/cables, measure insulation resistance of each wire/cable. Ensure readings are acceptable per installation recommendations. Tabulate and submit for approval as a submittal.
- 3.5.2. All Wires and Cables to be tested on site as defined in Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE and herein. Contractor to oversee all testing and correct any deficiencies noted.
- 3.6. INSTALLATION OF CONTROL CABLES
- 3.6.1. Install control cables in conduit.
- 3.6.2. Ground control cable shield.

END OF SECTION

26 05 26.00 Grounding + Bonding

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. CSA C22.2 No. 41– Grounding and Bonding of Equipment, latest edition.

1.2.2. Ontario Electrical Safety Code, latest edition.

1.2.3. Ontario Building Code, latest edition.

1.2.4. CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

1.2.5. IEEE Standard 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System, latest edition.

1.3. DESCRIPTION

1.3.1. Provide system grounding to meet requirements of current applicable codes.

1.4. SHOP DRAWINGS AND PRODUCT DATA

1.4.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4.2. Submit shop drawings for ground bars and ground rod inspection wells for engineer's review prior to manufacture.

1.4.3. Submit main system ground test report as a shop drawing for engineer's review. Include final reviewed report in the project O&M manuals.

1.5. WARRANTY

1.5.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. GROUNDING & BONDING EQUIPMENT

2.1.1. Meet standard of CSA C22.2 No. 41 – Grounding and Bonding of Equipment, latest edition.

2.2. CONDUCTORS

2.2.1. Bare or insulated, stranded, soft drawn annealed copper wire, for: ground bus, electrode interconnections, metal structures, ground connections, telephone ground.

2.3. LUGS

- 2.3.1. For all grounding and bonding connections onto bus work, utilize compression type fittings meeting the requirements of Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install complete permanent, continuous, system and circuit, equipment, grounding and bonding systems including, conductors, connectors, and accessories, as indicated, to conform to requirements of local authority having jurisdiction over installation.
- 3.1.2. Provide main station ground grid as shown on drawing but the ground grid shall consist of a minimum of four (4) driven ground rods. Copper ground rods shall be not less than 3 m long and 19 mm in diameter and where practicable located adjacent to the equipment to be grounded (i.e. main electrical room). Interconnect all ground rods underground with a #2/0 AWG bare ground conductor.
- .1 If main ground grid cannot be installed directly below the main electrical room, then provide a remote ground grid by installing the ground rods at the lowest floor level of the building and provide two grounding conductors of a minimum of #4/0 AWG copper to connect the ground grid to the main electrical room equipment. Run the two conductors through separate routes separated by a minimum of 5 m.
- 3.1.3. Supply and install a new ground bus system consisting of a length of copper bus, 25 mm thick ebony pad with chamfered edges as shown on the drawings. A minimum of two 1200 mm ground bars are to be provided in transformer vault(s), main electrical room(s) and generator room(s). Where a perimeter ground bus is shown on the drawings, supply and install a 50 mm x 6 mm copper bus on all walls attached at 1.5 m intervals on 13 mm standoffs. The perimeter ground bus shall be continuous around the room and shall be continued above or below all openings such as doors and vents.
- 3.1.4. Interconnect the ground bars to the ground grid with a minimum #2/0 AWG bare copper ground conductor if the ground grid is adjacent to the main electrical room(s). Where the ground grid is remote, connect the ground bars to the remote ground grid as described in 3.1.2.(1) above.
- 3.1.5. Supply and install inspection box for each ground rod. Inspection box is to be suitable for installation in heavy traffic areas and is to come complete with a lockable lid and security key.
- 3.1.6. Connect to the ground bus all metal equipment enclosures, as well as all other metal parts such as mechanical pipes, ducts, waste lines, door frames, railings, grilles, fences, etc. with minimum #2/0 AWG bare copper conductors.
- 3.1.7. For solidly grounded systems, transformer neutrals, main service entrance switchboard neutrals and all similar bonding connections, the bonding conductors shall be sized in accordance with Table 16 of the Electrical Code.
- 3.1.8. Provide cable grips to receive all grounding conductors. Identify all grounding conductors at the ground pad using lamacoid nameplates. Ground bus system to be provided in rooms as shown.
- 3.1.9. Terminate the following conductors at the ground bus system:
- Service neutral -as indicated on drawings

- Telecommunications ground

-as per TIA Standard 607, latest edition

TBB/GE linear length m (ft)	TBB/GE size (AWG)
less than 4 (13)	6
4 – 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8 – 10 (27 – 33)	2
10 – 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
20 – 26 (67 – 84)	3/0
26 – 32 (85 – 105)	4/0
32 – 38 (106 – 125)	250 kcmil
38 – 46 (126 – 150)	300 kcmil
46 – 53 (151 – 175)	350 kcmil
53 – 76 (176 – 250)	500 kcmil
76 – 91 (251 – 300)	600 kcmil
Greater than 91 (301)	750 kcmil

where,

TBB = Telecommunications Bonding Backbone

- Main system ground -#2/0 AWG or 2 x # 4/0 AWG for remote ground grids
- Bonding conductor -as per Table 16 of CSA C22.1

- 3.1.10. Ground all metallic water, gas, and waste systems with a minimum #6 AWG copper in accordance with code requirements.
- 3.1.11. Install bonding connections to typical equipment included in, but not necessarily limited to, following list: frames of motors, starters, control panels, building steel work, elevators, distribution panels and outdoor lighting.
- 3.1.12. Commission an approved certified testing Agency to perform a main system ground test. Submit the main system ground test report as a shop drawing for engineer's review. Provide a copy of the report in the maintenance manual. (Refer to Part 3.2).
- 3.1.13. Install connectors in accordance with manufacturer's instructions.
- 3.1.14. Ground rods to be interconnected by grounding grid conductors (sized as per sections above) and buried to a maximum depth of 600 mm below the rough station grade and a minimum depth of 150 mm below the finished station grade.
- 3.1.15. Protect exposed grounding conductors from mechanical damage.
- 3.1.16. Install bonding conductor for flexible conduit and connect at both ends to grounding bushing with solderless lug, clamp or cup washer and screw. Neatly cleat bonding conductor to exterior of flexible conduit.
- 3.1.17. Provide separate, insulated bonding conductor within each feeder and branch circuit raceway.
- 3.1.18. Interface with the lightning protection system, if one is installed for this building.
- 3.2. TESTING
 - 3.2.1. The contractor shall pay for the testing and verification of the entire building ground system using a certified testing Agency. Tests shall include main ground grid and ground rods, and grounding connections between all electrical and communication rooms. The agency shall provide complete test reports indicating test methodology and results. All costs shall be included in contract bid.

3.2.2. Following are acceptable methods of testing the ground grid. Testing shall be in accordance with IEEE Standard 81 (latest edition).

- .1 Two-Point Method
- .2 Three-Point Method
- .3 Ratio Method
- .4 Staged Fault Tests
- .5 Fall-of-Potential Method

END OF SECTION

26 05 29.00 Hangers and Supports

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. SHOP DRAWINGS AND PRODUCT DATA

1.2.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2.2. Conduit and equipment provided under the Electrical division shall be complete with all necessary supports and hangers required for a safe and workmanlike installation.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Provide “U” type support Strut as manufactured by Unistrut or Hilti.

3. Execution

3.1. INSTALLATION

3.1.1. All drilling for hangers, rod inserts and work of similar nature shall be done by this Division.

3.1.2. Auxiliary structural members shall be provided under the electrical section concerned where conduits or equipment must be suspended between the joists or beams of the structure, or where required to replace individual hanger to allow for installation on new services. Submit details for review as requested.

3.1.3. Depending on type of structure, hangers shall be either clamped to steel beams or joists, or attached to approved concrete inserts.

3.1.4. Approved type expansion shields and bolts may be used for conduit up to 103 mm diameter where the pre-setting of concrete inserts is not practical. Submit Shop Drawings.

3.1.5. Suspension from metal deck shall not be allowed unless specifically accepted by the Engineer's Representative. Drawings of the proposed method of suspension must be submitted for review.

3.1.6. Hangers, hanger rods and inserts in all parking and ramp areas shall meet the requirements of CAN/CSA-S413 – Parking Structures (latest edition) and shall be of corrosion-resistant material or have an effective, durable corrosion resistant coating. Submit samples for approval.

3.1.7. Suspending one hanger from another shall not be permitted.

3.1.8. All hangers, supports, brackets and other devices used outside the building wall shall be galvanized. If galvanized components cannot be used submit samples of proposed substituted for review before installation.

3.2. HORIZONTAL RUNS ON THE ROOF

3.2.1. Where conduit or cables are run horizontally across a roof, conduit or cable shall be supported from pre-manufactured UV resistant sleepers with closed cell foam base.

3.2.2. Sleepers shall be "E-Z Sleeper" product from Pipe-Ease Inc. or approved equivalent.

3.2.3. Wood Blocks are not acceptable.

END OF SECTION

26 05 31.00 Splitters, Junction, Pull Boxes and Cabinets

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 53.00 – IDENTIFICATION.

1.1.4. Section 26 05 63.00 – ACCESS DOORS AND ACCESSIBILITY.

1.2. REFERENCE

1.2.1. Ontario Electrical Safety Code, latest edition.

1.2.2. Ontario Building Code, latest edition.

1.2.3. CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit shop drawings and product data for cabinets in accordance with specification Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. SPLITTERS

2.1.1. Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position. Provide CSA Type 1 enclosures in non-sprinklered environments and CSA Type 4/12 in sprinklered environments.

2.1.2. Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated. Lugs to be dual rated for Copper/Aluminum (Cu/Al).

2.1.3. At least three spare terminals on each set of lugs in splitters less than 400 A.

2.2. JUNCTION AND PULL BOXES

2.2.1. Welded steel construction with screw-on flat covers for surface mounting.

2.2.2. Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

2.3. CABINETS

2.3.1. Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.

- 2.3.2. Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing 19 mm plywood backboard for surface or flush mounting. The plywood backboard is to have a fire-resistant coating on the front. Do not paint over plywood fire rating certification stamp.

3. Execution

3.1. SPLITTER INSTALLATION

- 3.1.1. Install splitters and mount plumb, true and square to the building lines.
3.1.2. Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2. JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- 3.2.1. Install pull boxes in inconspicuous but accessible locations.
3.2.2. Mount cabinets with top not higher than 2000 mm above finished floor.
3.2.3. Install terminal block as indicated in Type T cabinets.
3.2.4. Only main junction and pull boxes are indicated. Install pull boxes as follows:
.1 A conduit run exceeds 30 m and;
.2 360 degree of combined bends between pull boxes for power conduits or 180 degree of combined bends between pull boxes for communication and low voltage conduits.

3.3. IDENTIFICATION

- 3.3.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
3.3.2. Install identification labels indicating system name, voltage, and phase.

END OF SECTION

26 05 32.00 Outlet Boxes, Conduit Boxes and Fittings

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. REFERENCES

1.2.1. Ontario Electrical Safety Code, latest edition.

1.2.2. Ontario Building Code, latest edition.

1.2.3. CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. OUTLET AND CONDUIT BOXES GENERAL

2.1.1. Size boxes in accordance with the electrical code.

2.1.2. Square or larger outlet boxes as required for special devices.

2.1.3. Gang boxes where wiring devices are grouped.

2.1.4. Blank cover plates for boxes without wiring devices.

2.1.5. 347 V outlet boxes for 347 V switching devices.

2.1.6. Combination boxes with barriers where outlets for more than one system are grouped.

2.2. SHEET STEEL OUTLET BOXES

2.2.1. Electro-galvanized steel single and multi-gang flush device boxes for flush installation, minimum size 75 mm x 50 mm x 38 mm or as indicated. 100 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

2.2.2. Provide cast FS aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles connected to rigid conduit.

2.2.3. Provide electro-galvanized steel utility boxes for surface mounted boxes connected to surface-mounted EMT conduit, minimum size 100 mm x 54 mm x 48 mm.

2.2.4. Square or octagonal outlet boxes for lighting fixture outlets.

2.2.5. Square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.3. MASONRY BOXES

2.3.1. Electro-galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.

2.4. CONCRETE BOXES

- 2.4.1. Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5. FLOOR BOXES

- 2.5.1. Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum faceplate. Device mounting plate to accommodate short or long ear duplex receptacles. Minimum depth: 28 mm for receptacles; 73 mm for communication equipment.
- 2.5.2. Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 16 mm and 21 mm conduit. Minimum size: 73 mm deep.

2.6. OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

- 2.6.1. Electro-galvanized, sectional, screw ganging steel boxes, minimum size 75 mm x 50 mm x 63.5 mm with two double clamps to take non-metallic sheathed cables.

2.7. FITTINGS - GENERAL

- 2.7.1. Bushing and connectors with nylon insulated throats.
- 2.7.2. Knock-out fillers to prevent entry of debris.
- 2.7.3. Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.
- 2.7.4. Double locknuts and insulated bushings on sheet metal boxes.

2.8. SERVICE FITTINGS

- 2.8.1. 'High tension' receptacle fitting made of 2 piece die-cast aluminum with brushed aluminum housing finish for duplex receptacles. Bottom plate with two knockouts for centered or offset installation.
- 2.8.2. Pedestal type 'low tension' fitting made of 2 piece die cast aluminum with brushed aluminum housing finish to accommodate Amphenol jack connectors.

3. Execution

3.1. INSTALLATION

- 3.1.1. Support boxes independently of connecting conduits.
- 3.1.2. Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- 3.1.3. For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- 3.1.4. Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- 3.1.5. Non-combustible electrical outlet boxes that penetrate a vertical fire separation or a membrane forming part of an assembly required to have a fire-resistance rating, do not require fire stops provided,
- .1 they do not exceed:
- .1 160 cm² (0.016 m²) each in area, AND

- .2 an aggregate area of 650 cm² (0.065 m²) in any 9.3 m² of surface area, AND
- .2 The annular space between the membrane and the box does not exceed 3 mm.
- 3.1.6. Where the conditions of clause 3.1.5 are not met, provide fire stops for the outlet boxes.
- 3.1.7. Opposing outlets on non-fire rated partition walls shall have a minimum 150 mm horizontal separation. Outlets shall not be mounted back to back.
- 3.1.8. Conform to the fire stopping requirements of the building code: unless provided with a fire stop in accordance with CAN/ULC-S115, "Fire Tests of Fire Stop Systems", electrical outlet boxes on opposite sides of a vertical fire separation required to have a fire-resistance rating shall be separated by a horizontal distance of not less than 600 mm, or be installed in adjacent stud cavities.

END OF SECTION

26 05 34.00 Conduits, Conduit Fasteners and Fittings

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 31.00 – SPLITTERS, JUNCTION, PULL BOXES AND CABINETS

1.1.3. Section 26 05 32.00 – OUTLET BOXES, CONDUIT BOXES AND FITTINGS

1.2. REFERENCES

1.2.1. CAN/CSA C22.2 No.18 - Outlet Boxes, Conduit Boxes, and Fittings, latest edition.

1.2.2. CSA C22.2 No.45.1 - Electrical Rigid Metal Conduit - Steel, latest edition.

1.2.3. CSA C22.2 No.56 - Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit, latest edition.

1.2.4. CSA C22.2 No.83 - Electrical Metallic Tubing, latest edition.

1.2.5. CSA C22.2 No.211.2 - Rigid PVC (Unplasticized) Conduit, latest edition.

1.2.6. CAN/CSA C22.2 No.227.3 - Flexible Non-metallic Tubing, latest edition.

1.2.7. CSA C22.2 No.227.1 - Electrical Non-Metallic Tubing, latest edition.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. CONDUITS

2.1.1. Electrical rigid metal conduit: to CSA C22.2 No.45.1, galvanized steel or aluminum threaded.

2.1.2. Epoxy coated conduit: to CSA C22.2 No.45, with zinc coating and corrosion resistant epoxy finish inside and outside.

2.1.3. Electrical metallic tubing (EMT): to CSA C22.2 No.83, with couplings.

2.1.4. Rigid PVC conduit: to CSA C22.2 No.211.2.

2.1.5. Flexible metal conduit: to CSA C22.2 No.56, steel or liquid-tight flexible metal.

2.1.6. Electrical non-metallic tubing (ENT): to CSA C22.2 No. 227, with couplings.

2.2. CONDUIT FASTENINGS

2.2.1. One-hole steel straps to secure surface conduits NPS 2 and smaller. Two-hole steel straps for conduits larger than NPS 2.

2.2.2. Beam clamps to secure conduits to exposed steel work.

2.2.3. Channel type supports for two or more conduits at 1 m on centre.

2.2.4. Hot dipped galvanized threaded rods, 6 mm dia. minimum, to support suspended channels.

- 2.2.5. For non-fire rated applications, pre-engineered support systems complying with CSA C22.2 No. 18.4 "Hardware for the support of conduit, tubing, and cable (Bi-national standard with UL 2239)."
- 2.3. CONDUIT FITTINGS
- 2.3.1. Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- 2.3.2. Factory 90 degree elbow where 90 bends are required for 1" and larger conduits when a hydraulic bender is not used.
- 2.3.3. Connectors, and couplings for EMT conduit are to be set-screw steel type. Below the level of suspended ceilings, in a sprinklered environment, provide watertight fittings and "O" rings on all conduit runs and when conduit is terminated at any piece of electrical equipment.
- 2.3.4. Provide plastic bushings for all connectors, rigid nipples and rigid conduit 35 mm or larger.
- 2.4. EXPANSION FITTINGS FOR RIGID CONDUIT
- 2.4.1. Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- 2.5. FISH CORD
- 2.5.1. Fish cord to be made of polypropylene.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Do not embed conduits in horizontal concrete floor/ceiling slabs and instead install conduits below the ceiling slab in the ceiling space, unless written consent for embedded conduits is received from the Engineer's Representative. Assume installation of conduits in the ceiling space as a basis of bid. The clauses in this and other spec sections related to conduits embedded in concrete slabs only apply if written consent has been granted by the Engineer's Representative.
- 3.1.2. Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- 3.1.3. Do not install conduits, associated raceway system, or devices on the surface of, or within 100 mm of the underside of roof decks.
- 3.1.4. Conceal conduits except in mechanical and electrical service rooms or in unfinished areas. Conduits to have their own support system and are to be supported independently of the ceiling grid or ceiling support system.
- 3.1.5. Where vertically run conduit passes through a slab, Contractor to provide a 100 mm high concrete pad with the pad extending 100 mm on all sides of the conduit.
- 3.1.6. Use electrical metallic tubing (EMT) conduit except where specified otherwise.
- 3.1.7. Use epoxy coated conduit in corrosive areas.
- 3.1.8. Use rigid galvanized steel threaded conduit where conduit is subject to mechanical damage.
- 3.1.9. Use rigid PVC conduit underground or in corrosive areas and where indicated.

- 3.1.10. Use flexible metal conduit for connection to motors or vibrating equipment in dry areas, connection to recessed luminaires without a prewired outlet box, connection to surface or recessed luminaires and work in movable metal partitions. Ensure slack is provided in wiring connections to equipment which contains moving parts.
- 3.1.11. Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations. Use only liquid tight fittings when using liquid tight flexible metal conduit. Liquid tight flexible metal conduit to have a jacket with an FT6 rating when used in plenums otherwise provide a minimum FT4 rating. Ensure slack is provided in wiring connections to equipment which contains moving parts.
- 3.1.12. Use explosion proof flexible connection for connection to explosion proof motors.
- 3.1.13. Install conduit sealing fittings in hazardous areas. Fill with compound.
- 3.1.14. Minimum conduit size for lighting and power circuits: NPS 21 mm, unless otherwise noted on the Drawings.
- 3.1.15. Minimum conduit size for data / voice cabling: as indicated on drawings, otherwise 27 mm.
- 3.1.16. Install EMT conduit from a raised floor branch circuit panel to outlet boxes located in sub floor.
- 3.1.17. Install EMT conduit from a raised floor branch circuit panel to junction box in sub-floor. Run flexible metal conduit from junction box to outlet boxes for equipment connections in sub-floor.
- 3.1.18. Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- 3.1.19. Mechanically bend steel conduit over 21 mm diameter.
- 3.1.20. Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- 3.1.21. Install fish cord in empty conduits.
- 3.1.22. Run two 27 mm spare conduits up to ceiling space and two 27 mm spare conduits down to sub-floor space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm junction boxes or in case of an exposed concrete slab, terminate each conduit in flush concrete or surface type box.
- 3.1.23. Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- 3.1.24. Dry conduits out before installing wire.
- 3.1.25. All cutting and patching of masonry/concrete floors, walls, and roof for electrical services shall be by this Division. Obtain approval from the Landlord and/or structural Engineer's Representative before cutting any structural walls or floors. Cutting and drilling shall only be at times allowed by the Landlord. Check and verify the location of existing mechanical and electrical services in walls and below the floor slab in all areas requiring core drilling and cutting. Protect all tenant areas where core drilling occurs. Carefully chip top and bottom of slab to expose rebar to minimize cutting of rebar when core drilling. Provide x-ray study before drilling or cutting where required by the Landlord and/or structural Engineer's Representative.
- 3.1.26. Provide sleeves for all new conduit passing through floor and roof slabs, beams, concrete walls and slab to slab partitions, etc.
- 3.1.27. Where cables and conduits pass through partitions and through floors that are not fire rated, provide an air-tight seal around the cables and conduits.
- 3.1.28. Where cables and conduits pass through floors and fire rated walls, pack space between conduit (or cable) and sleeve with an approved fire stop as specified in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

- 3.1.29. Prior to installation of any wire or cable in direct buried conduits or the conduits in an underground duct bank, pull through each conduit a flexible mandrel not less than 300 mm long and size for the internal diameter of conduit, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging conduits where concrete has not set completely. Provide photo and video evidence of compliance with this clause and send to Engineer's Representative for review within 24 hours of Work occurring.

3.2. SURFACE CONDUITS

- 3.2.1. Run parallel or perpendicular to building lines.
- 3.2.2. Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- 3.2.3. Run conduits in flanged portion of structural steel.
- 3.2.4. Group conduits wherever possible on suspended or surface mounted channels.
- 3.2.5. Do not pass conduits through structural members, except as indicated.
- 3.2.6. Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- 3.2.7. Conduits must not be used to support other conduits.

3.3. CONCEALED CONDUITS

- 3.3.1. Run parallel or perpendicular to building lines.
- 3.3.2. Do not install horizontal runs in masonry walls.
- 3.3.3. Do not install conduits in terrazzo or concrete toppings.

3.4. CONDUITS IN CAST-IN-PLACE CONCRETE

- 3.4.1. Locate to suit reinforcing steel. Install in centre one third of slab.
- 3.4.2. Protect conduits from damage where they stub out of concrete.
- 3.4.3. Install sleeves where conduits pass through slab or wall.
- 3.4.4. Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.
- 3.4.5. Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.
- 3.4.6. Encase conduits completely in concrete with minimum 25 mm concrete cover.
- 3.4.7. Organize conduits in slab to minimize cross-overs.

3.5. CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

- 3.5.1. Run conduits 27 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.

3.6. CONDUITS UNDERGROUND

- 3.6.1. Slope conduits to provide drainage.
- 3.6.2. For all non-PVC conduits run underground, provide waterproof joints with heavy coat of bituminous paint.

END OF SECTION

26 05 36.00 Cable Trays

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. SECTION INCLUDES

1.2.1. Cable trays and accessories.

1.3. REFERENCES

1.3.1. Ontario Electrical Safety Code.

1.3.2. Ontario Building Code.

1.3.3. CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

1.3.4. CSA-C22.2 No. 126.1 – Metal Cable Tray Systems, latest edition.

1.3.5. CSA-C22.2 No. 126.2 – Non-metallic Cable Tray Systems, latest edition.

1.3.6. ASTM B 633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel, latest edition.

1.3.7. ASTM A 653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process, latest edition.

1.3.8. ASTM A 123 – Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel, latest edition.

1.3.9. ASTM A 510 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, latest edition.

1.3.10. NEMA VE 1 – Metal Cable Tray Systems, latest edition.

1.3.11. NEMA VE 2 – Cable Tray Installation Guidelines, latest edition.

1.3.12. ASTM A 641 – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire, latest edition.

1.3.13. ASTM A 580 – Standard Specification for Stainless Steel Wire, latest edition.

1.3.14. ASTM D 769 – Standard Specification for Black Oxide Coatings, latest edition.

1.4. SHOP DRAWINGS AND PRODUCT DATA

1.4.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4.2. Shop Drawings: Indicate tray type, dimensions, support points, and finishes.

1.4.3. Product Data: Provide data for fittings and accessories.

1.4.4. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agencies specified under article 1.3 –References. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.5. PROJECT RECORD DOCUMENTS

- 1.5.1. As-Built Drawings to indicate actual routing of cable tray and locations of supports.

1.6. QUALIFICATIONS

- 1.6.1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years of experience.
- 1.6.2. Furnish products listed and classified by UL Inc., CSA, CUL, as suitable for purpose specified and shown.

1.7. WARRANTY

- 1.7.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. LADDER-TYPE CABLE TRAY

- 2.1.1. Description: CSA-C22.2 No. 126, NEMA VE 1.
- 2.1.2. Load Class: Unless otherwise noted on the drawings, cable tray shall be **Choose an item..**
- 2.1.3. Material: Hot dipped galvanized steel.
- 2.1.4. Inside Width: as indicated.
- 2.1.5. Inside Depth: 100 mm or as indicated.
- 2.1.6. Straight Section Rung Spacing: 300 mm on centre for electrical wiring or 150 mm on centre on communication cable trays.
- 2.1.7. At junctions of cable trays provide manufactured transition pieces with a bending radius equal to or larger than the width of the cable tray.
- 2.1.8. Provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
- 2.1.9. Covers: not required unless indicated on Drawings.

2.2. WIRE BASKET SECTIONS AND COMPONENTS

- 2.2.1. Provide wire basket of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
- 2.2.2. Materials and Finishes: Material and finish specifications for wire basket sections and components to be electrodeposited zinc plating in accordance with ASTM B 633, Type III, SC-1, with straight sections made from carbon steel wire, ASTM A 510, Grade 1008, unless one of the following finishes is noted on the drawings:
- .1 Stainless Steel: Straight sections and accessories shall be made from AISI Type 316L Stainless Steel meeting the minimum mechanical properties of ASTM A 580.
 - .2 Powder Coat: Straight sections shall be powder coated black with an average paint thickness of 1.2 mils (30 microns) to 3.0 mils (75 microns). Colour to be custom and selected during shop drawing stage.

- .3 Hot Dipped Galvanizing: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A 510, Grade 1008 and shall be hot dipped galvanized after fabrication in accordance with ASTM A 123.

2.2.3. Type of Wire Basket Support System

- .1 All straight section longitudinal wires shall be constructed with a continuous top wire safety edge. Safety edge must be kinked and T-welded on all tray sizes.
- .2 Wire basket shall be made of high strength steel wires and formed into a standard 50 mm by 100 mm wire mesh pattern with intersecting wires welded together. All mesh sections must have at least one bottom longitudinal wire along entire length of straight section.
- .3 Wire basket sizes shall conform to the following nominal criteria:
 - .1 Straight sections shall be furnished in standard lengths.
 - .2 Wire diameter shall be 5 mm minimum on all mesh sections.
 - .3 Wire basket shall have a minimum usable loading depth of 100 mm unless 50 mm or 150 mm is noted on the drawings by a width noted on the drawings. If no width is detailed then 300 mm will be the minimum.
- .4 All fittings shall be field formed, from straight sections, in accordance with manufacturer's instructions.
- .5 All splicing assemblies shall be UL/CSA approved as a bonding conductor. When using powder coated wire basket as bonding conductor, the paint must be completely removed at all contact points of splice/ground bolt attachment.
- .6 Wire basket supports shall be trapeze hangers unless center support hangers or wall brackets are noted on the drawings. Trapeze hangers or center support hangers shall be supported by 1/4 inch or 3/8 inch diameter threaded rods or pre-engineered support systems complying with CSA C22.2 No. 18.4 "Hardware for the support of conduit, tubing, and cable (Bi-national standard with UL 2239)."
- .7 Special accessories shall be furnished as required to protect, support and install a wire basket support system.

2.2.4. Provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

2.2.5. Covers: not required unless indicated on drawings.

2.3. WARNING SIGNS

2.3.1. Nameplates: 12.7 mm high black letters on yellow plastic nameplates, with the following wording:

- .1 WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

2.4. MANUFACTURERS

2.4.1. The following are approved manufacturers:

- .1 CER- Canadian Electric Raceways.
- .2 Pursley.
- .3 B-Line.
- .4 Pilgrim.
- .5 Columbia-MBF-Cope.

- .6 Legrand.
- .7 ABB / Thomas & Betts.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install in accordance with manufacturer's instructions.
- 3.1.2. Install metallic cable tray in accordance with NEMA VE 1. Install wire basket in accordance with NEMA VE-2, to ensure that the cable tray equipment complies with requirements of all applicable codes including the local electrical code.
- 3.1.3. Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports of 3 m.
- 3.1.4. Use expansion connectors where required.
- 3.1.5. Grounding and bonding:
 - .1 Provide continuity between tray components.
 - .2 Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
 - .3 Provide #6 AWG bare copper bonding conductor through entire length of tray; bond to each component.
 - .4 Connections to tray may be made using mechanical or exothermic connectors.
- 3.1.6. Install warning signs at 15.25 m centers along cable tray, located to be visible.

END OF SECTION

26 05 53.00 Identification

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. Ontario Electrical Safety Code.

1.2.2. Ontario Building Code.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. EQUIPMENT IDENTIFICATION

2.1.1. Identify electrical equipment with nameplates as follows:

- .1 Lamacoid 3 mm thick plastic engraved sheet, black or red face, white core, mechanically attached with self-tapping screws or rivets.
- .2 White letters 12 mm high for major switchboards, panelboards and power transformers.
- .3 White letters 12 mm high for terminal boxes, junction boxes, grid boxes, splitter boxes, disconnect switches starters and contactors.
- .4 Allow for an average of fifty (50) to one hundred (100) letters per nameplate.
- .5 Identification to be in English.
- .6 Black nameplates for normal power.
- .7 Red nameplates for emergency power.
- .8 Blue nameplates for UPS Power.
- .9 Sample:

SWITCHBOARD AA 3000A, 600/347V, 3 PH, 4W, 50kA FED FROM SWITCHBOARD AAA

MANUFACTURED IN MM/YYYY; SERIAL NUMBER ##-####

- .10 Wording on nameplates to be approved by Engineer's Representative prior to manufacture.
- .11 Nameplates for splitters, terminal cabinets, grid boxes, pull boxes, and junction boxes are to indicate the system and/or voltage characteristics.
- .12 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .13 Transformers: indicate capacity, primary and secondary voltages, and upstream source where Transformer is fed from.
- .14 Mechanical equipment: indicate equipment name and full circuit number including panel board identification.
- .15 Switchboards, Distribution Panels, and Panelboards: Name designation, rated ampacity, voltage, number of phases, and number of wires, if neutral is rated for 200%, interrupting capacity in units of kA, upstream source from which panelboard is fed, month and year manufactured, and serial number.
- .16 Automatic Transfer Switches (ATS): Name designation, rated ampacity, voltage, transfer switch arrangement (e.g. 3 pole with no neutral, 3 pole with solid neutral, 3 pole with overlapping neutral, 4 pole), withstand rating in units of kA, upstream normal power source from which ATS is fed, upstream emergency power source from which ATS is fed, month and year manufactured, and serial number.
- .17 Generators:
 - .1 Indicate kW rating, kVA rating, voltage, number of phases, number of wires, generator neutral grounding arrangement, year and month manufactured, and engine and alternator serial number.
 - .2 Indicate Maximum Site Design Load (as defined in CSA C282) in units of kW; engineering firm responsible for Maximum Site Design Load calculation; drawing number, issuance title (e.g. Issued for Construction, Electrical Contactor As-Built, Issued for CCN-E01, etc.), and issuance date which Maximum Site Design Load is based on. It is very important for future renovations and load additions that it is clear when the Maximum Site Design Load is from and what drawing it is based on.
 - .3 Sample nameplate:

Generator G1
600 kW / 750 kVA
600/347V, 3 PH, 4W, Wye solidly grounded
Connected to ATS-PHXA
MANUFACTURED IN MM/YYYY; SERIAL NUMBER ##-####
Maximum Site Design Load 420 kW

- .18 Provide nameplates on all electrical equipment including:
 - .1 Splitters, terminal cabinets, grid boxes, pull boxes, and junction boxes

- .2 Disconnects, starters and contactors, and Mechanical equipment
- .3 Transformers
- .4 Switchgear, Switchboards, Distribution Panels, and Panelboards
- .5 Automatic Transfer Switches
- .6 Generators
- .7 UPS equipment
- .8 Lighting control systems

2.1.2. Labels:

- .1 A printed label, similar to a Brady label 6 mm high letters unless specified otherwise, for internal components, such as relays, fuses, terminal blocks.

2.2. WIRING IDENTIFICATION

- 2.2.1. Identify wiring with permanent legible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- 2.2.2. Maintain phase sequence and colour coding throughout.
- 2.2.3. Colour code: in conformance with the electrical code.
- 2.2.4. Use colour coded wires in communication cables and control wiring, matched throughout system.

2.3. CONDUIT AND CABLE IDENTIFICATION

- 2.3.1. Colour code conduits, boxes and metallic sheathed cables.
- 2.3.2. Code with plastic tape, paint, or coiled conduit markers at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- 2.3.3. Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour:
 - .1 up to 250 V Normal Power = Green
 - .2 up to 600 V Normal Power = Blue
 - .3 up to 250 V Emergency Power = Black
 - .4 up to 600 V Emergency Power = Orange
 - .5 High Voltage, greater than 750 V = Large independent label clearly identifying the voltage
 - .6 Telephone/Data = White
 - .7 Fire alarm = Red
 - .8 Other security systems = Yellow
 - .9 Controls = Purple

2.4. RECEPTACLE IDENTIFICATION

- 2.4.1. All receptacles including systems furniture receptacles and whip connections are to be labelled with the respective circuit numbers with a printed label, similar to a Brady label, with 12 mm characters. Circuit number to include full circuit number including panel board identification.
- 2.4.2. Label to be placed on wall above cover plate or on cover plate. Location of label to be consistent throughout project.

2.5. MANUFACTURERS AND CSA LABELS

2.5.1. Visible and legible after equipment is installed.

2.6. WARNING SIGNS

2.6.1. Provide warning signs, as specified, and/or to meet the requirements of the Inspection Authorities.

2.7. FUSE SIZE LABELLING

2.7.1. Contractor to install a label on all equipment with fuses to identify the fuse sizes and class that are installed in the respective equipment.

2.7.2. Contractor to also install a label on all equipment with fuses to identify the maximum allowable fuse size based on the size of the respective feeders.

3. Execution

3.1. NOT USED

END OF SECTION

26 05 63.00 Access Doors and Accessibility

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. SHOP DRAWINGS AND PRODUCT DATA

1.2.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2.2. Submit drawings showing size, type and location of all access doors, for review, before installation.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Access doors shall be Acudor, or LeHage or Mifab. Coordinate with other trades on site. All access doors on site shall be from the same manufacturer.

2.1.2. Doors in solid walls shall be equal to Acudor Model UF5000 with 14 U.S. gauge, prime painted steel door panel, rust resistant concealed hinges and screwdriver operated lock .

2.1.3. Doors in plaster partitions or ceiling shall be equal to Acudor model AP5010 16 US gauge, prime painted steel, concealed hinges and screwdriver operated lock.

2.1.4. Doors in drywall partitions or ceiling shall be equal to Acudor model DW 5040, 20 US gauge, prime painted steel, concealed hinges and screwdriver operated lock .

2.1.5. Access doors in fire rated walls or ceilings shall be equal to Acudor Model FW 5050 and ULC labeled with insulated door panel, concealed hinge, self-closing, self-latching, and prime painted. Provide master key operated catch in areas accessible to the public.

2.1.6. All doors in tiled walls shall be 16 US gauge, stainless steel, type 304 with #4 satin finish, concealed hinges, wall frame and screw driver operated lock.

2.1.7. Minimum size of doors shall be 300 mm x 450 mm. Wherever possible 600 mm x 600 mm doors shall be used.

3. Execution

3.1. INSTALLATION

- 3.1.1. All parts of the installation requiring periodic maintenance shall be accessible. Wherever pull boxes, junction boxes and other appurtenances are concealed by building construction, access doors shall be furnished by this section and installed under the respective Trade Sections (i.e. masonry, plaster, drywall, tile, etc.). This section is responsible for the proper location of the access doors.
- 3.1.2. Wherever possible, items requiring access shall be located in easily accessible areas (i.e. exposed or T-bar ceilings).
- 3.1.3. Group items in order to minimize the number of access doors required.
- 3.1.4. Each access door shall be installed to provide complete access to equipment for maintenance and servicing.
- 3.1.5. Make any changes to locations of access doors as directed by the Engineer's Representative.
- 3.1.6. The final installed locations of all access doors shall be shown on the As-Built Drawings.

END OF SECTION

26 05 73.00 Electrical Power System Studies

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
 - 1.2. REFERENCES
 - 1.2.1. CSA Z462 – Workplace Electrical Safety, latest edition.
 - 1.2.2. IEEE 1584 – IEEE Guide for Performing Arc Flash Hazard Calculations, latest edition.
 - 1.2.3. NFPA 70E – Standard for Electrical Safety in the Workplace, latest edition.
 - 1.3. SUMMARY
 - 1.3.1. The electrical power system studies for the project shall be performed by an approved electrical power systems contractor. The type and content of each study is specified in the following articles.
 - 1.3.2. The extent of the power systems studies shall include from the main utility connection down to the branch circuit panels. All relays and fuse sizes to be included to ensure the best operation of the entire system. The studies shall also be performed to include the operation of the emergency power generation system.
 - 1.3.3. Contractor to label and re-label with the appropriate Client approved label all equipment that is new or the calculated values have changed from what is currently shown.
 - 1.4. SHOP DRAWINGS AND PRODUCT DATA
 - 1.4.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
 - 1.4.2. Completed electrical power system studies shall be bound and submitted to the Engineer. Submit initial version(s) of the power system studies during the project shop drawing stage. Submit another “final” version of the power system studies at the end of the project utilizing the final/installed values. The study must be stamped and signed by a professional engineer in the applicable jurisdiction of the project for all submissions.
 - 1.4.3. Contractor providing electrical power systems study to allow for revisions/adjustments based on review comments and actual transformer impedances.
 - 1.4.4. Provide a minimum of three (3) bound coloured copies of all submissions to Owner and Engineer for review. Modify studies based on comments received and continue to re-issue until an accepted version is agreed upon.
 - 1.4.5. Provide a copy of the working electronic file in native program format along with each of the final copies of the studies. Identify what software was used to complete the studies. The information contained within the project file remains the property of the owner and can be used by the Owner for future system modifications.
 - 1.4.6. Provide samples of the proposed arc flash labels. All labels to match the Owners standard labels.

- 1.4.7. Contractor shall submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, contractor shall submit at a minimum a preliminary short circuit study for review.
- 1.5. WARRANTY
- 1.5.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
2. Product
- 2.1. ELECTRICAL POWER SYSTEM STUDIES
- 2.1.1. Short-Circuit Analysis
- .1 Calculation of maximum RMS symmetrical three-phase short-circuit and single line to ground fault current at each significant location in the electrical system shall be made using a digital computer.
 - .2 Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.
 - .3 A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.
 - .4 The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
 - .5 Include a computer printout identifying the maximum available short-circuit current in RMS symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.
 - .6 The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.
 - .7 A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for the improvements to the system.
 - .8 The contractor shall be responsible for supplying conductor information (lengths, types, number per phase, etc.) in a timely manner to allow the short-circuit analysis to be completed prior to final installation.
 - .9 Any inadequacies shall be called to the attention of the engineer and recommendations made for improvements as soon as they are identified.
- 2.1.2. Protective Device Time-Current Coordination Analysis
- .1 The time-current coordination analysis shall be performed with the aid of a digital computer and will include the determination of settings, ratings, or types for the over-current protective devices supplied.

- .2 A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected over-current devices and other pertinent system parameters.
- .3 Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
- .4 The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable over-current protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.
- .5 A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
- .6 A discussion section which evaluates the degree of system protection and service continuity with over-current devices, along with recommendations as required for increasing system protection or device coordination.
- .7 Significant deficiencies in protection and/or coordination shall be called to the attention of the engineer and recommendations made for improvements as soon as they are identified.

2.1.3. Arc Flash/Incident Energy Study

- .1 An Arc Flash/Incident Energy Study shall be performed to determine the incident energy and arc flash protection boundary at each piece of electrical equipment and to identify the level of PPE required by people working on that respective equipment.
- .2 The study shall take into account all the information set forth in the short circuit study and the coordination study. Contractor to use the minimum and maximum fault currents provided by the utility to determine the worst incident energy levels. Provide two columns in your arc flash summary sheet identifying the current at both fault levels. Contractor to revisit the coordination study and revise coordination to provide the minimum incident energy levels as possible. Provide recommendations to reduce the incident energy levels even further at the risk of affecting the coordination to allow Owner and Engineer's Representative to review options and provide feedback.
- .3 Calculate the arc flash hazard, incident energy level and the flash protection boundary as per IEEE 1584. PPE level recommendations as per NFPA 70E / CSA Z462.
- .4 All electrical equipment to be identified with the incident energy, flash protection boundary and level of PPE required.
- .5 Purpose made labels to be provided on all electrical equipment. All equipment where levels were not calculated are to be provided with a standard warning label. Label samples to be submitted for review by Owner and Engineer's Representative. Where equipment includes or is fed from a breaker with two sets of trip curves (i.e. a maintenance mode energy reducing trip curve), provide two labels, one for each trip curve.

2.2. APPROVED ELECTRICAL POWER SYSTEMS CONTRACTORS

2.2.1. The power system studies shall be completed by qualified and experienced personnel.

2.2.2. The specified electrical power system studies shall be performed by:

- .1 Schneider-Electric Services.

- .2 Eaton - Cutler-Hammer Service Group.
- .3 ABB.
- .4 G.T. Wood.
- .5 K-Line – K-Tek.
- .6 Pelikan Inc.
- .7 General Electric (GE).
- .8 Eastenghouse.
- .9 AC Tesla.
- .10 Brosz Technical Services.
- .11 Qualus Services Canada Ltd.

3. Execution

3.1. GENERAL

- 3.1.1. Contractor to include for all on site surveys and investigations in order to obtain all the relevant information to complete all the studies.
- 3.1.2. The relays and equipment will be set up on site by the Technical Services Division Startup Service Contractor. Coordinate with this Contractor to ensure information is relayed accordingly.
- 3.1.3. Review work on site to ensure equipment has been set up as per the coordination study. Have the Technical Services Division Startup Service Contractor test systems at random to ensure the coordination study has been adhered to.
- 3.1.4. Submit a report and a letter reporting to the Engineer and Owner that the coordination study information has been followed.
- 3.1.5. Contractor to revise fuse sizes as identified in the report and modify the drawings to represent as-built conditions.

3.2. LABELLING

- 3.2.1. Have power system study specialist install arc flash labels on all equipment. Coordinate with the Electrical Contractor.
- 3.2.2. Where manufacturer listed series ratings are permitted by other specification sections within this specification, install UL series rating labels on all devices/equipment that are part of a series rated combination. Ensure that labels comply with the "Series rated combinations" rule within the Electrical Code.

3.3. TRAINING

- 3.3.1. Provide one day of in-depth training on arc-flash safety detailing the industry and code requirements including the details of the specific project for the Owner and the Owner's representatives.

END OF SECTION

26 05 83.00 Sleeves

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. Sleeves passing through stud partitions shall be 0.75 mm 22 US Gauge steel.

2.1.2. Sleeves passing through masonry walls shall be Schedule 40 steel pipe.

2.1.3. Sleeves passing through floors in finished areas and concealed spaces may be sheet metal or factory fabricated reusable type.

2.1.4. Where a housekeeping pad cannot be installed, sleeves passing through floors with waterproof membrane shall have a flashing collar, 50 mm wide at the membrane level. Flashing collar shall be continuously welded to sleeve. Sleeves shall extend 50 mm above the finished floor and shall be Schedule 40 steel pipe.

2.1.5. Where conduits pass through exterior foundation walls 6 mm thick steel sleeve of inside diameter not less the 75 mm greater than the outside diameter of the pipe shall be used and shall be complete with anchor collar. Thunderline Link-Seal wall seal or approved equal shall be used for the annular space between the sleeve and the conduit. A reinforced concrete bridge shall be installed between the wall and the adjacent undisturbed soil.

2.1.6. Provide adequate bracing for support of sleeves during concrete and masonry work.

2.1.7. Unless otherwise specified on the drawings, sleeves passing through the roof shall be liquid tight flexible conduit flashing consisting of a gooseneck shaped aluminum flashing sleeve with an integral deck flange, EPDM end cap seal and EPDM base seal.

3. Execution

3.1. INSTALLATION

3.1.1. Arrange for all chases and formed openings in walls and floors as required by the Electrical Division for the Electrical services. These chases and openings shall not be larger than necessary to accommodate the equipment and services. Advise on these requirements well in advance, before the concrete is poured and the walls are built. All necessary sleeves and inserts shall be supplied by this Division.

3.1.2. Chases and openings not located in accordance with the above provisions shall be made at the expense of this Division. Cutting of structural members shall not be permitted without specified written acceptance of the Engineer's Representative.

- 3.1.3. Provide sleeves for all service penetrations through walls, partitions, floor slabs, plenums and similar barriers. At non-rated barriers fill the annular space between the service and the sleeve with fire rated insulation as specified for rated separations and caulk around the edges with a minimum 12 mm thick of fire rated compound or acoustic non-setting mastic.
- 3.1.4. Through all fire or smoke separations, after testing, the annular space between conduit sleeves shall be fire stopped.
- 3.1.5. Where-holes are to be installed in existing structure, contractor is to core drill the-holes required. Contractor is required to scan all areas prior to coring and confirm layout with structural engineer prior to completing work. When installing sleeves in existing structures, sleeves shall be provided as specified complete with a combination puddle/anchor flange bolted to the floor. Seal watertight between the flange and the floor.
- 3.1.6. All sleeves are to extend 150 mm above finished floor to accommodate a 100 mm concrete pad. Contractor to pour the concrete pad with the pad extending 100 mm on all sides of the sleeve.

END OF SECTION

26 05 88.00 Cutting and Patching

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. WARRANTY

1.2.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. All services and materials used for the cutting and patching shall meet all requirements specified in Div. 00, and Section 26 05 01.00, and shall be carried out by experienced workers.

2.1.2. Include for all cutting and patching for all Electrical services.

3. Execution

3.1. INSTALLATION

3.1.1. Cut all openings no larger than is required for the services. Core drill for individual services.

3.1.2. Obtain approval from the structural Engineer's Representative before cutting or core drilling any openings or-holes in slabs or structural elements.

3.1.3. Locate all openings in structure elements requiring cutting and patching, and x-ray the structure to obtain Structural Engineer's Representative's approval prior to cutting or core drilling of existing structure. Make adjustments to location of openings as required to minimize cutting of rebar, and completely avoiding electrical conduit.

.1 Cut-holes through slabs only.

.2 Do not cut-holes through beams.

.3 Holes to be cut are 200 mm (Diameter) or smaller only.

.4 Maintain at least 100 mm clear from all beam faces. Space at least 3-hole diameters on Centre.

.5 For-holes that are required closer than 25% of slab span from the supporting beam face, use cover meter above the slab to clear slab top bars.

.6 For-holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars.

3.1.4. X-ray scanning:

.1 X-rays shall be performed by a qualified technician, in a safe manner and in accordance with all applicable regulations governing this activity. The company shall be licensed by the Canadian Nuclear Safety Commission (CNSC), and all radiography work shall be performed in accordance with the Nuclear Safety and Control Act.

- .2 Follow any safety requirements stipulated by the property manager.
 - .3 Minimum requirements: All people must be evacuated within a radius of 10 m from each exposure location. Prior to conducting exposures verify this "safe zone". If the 10 m radius includes public areas such as a sidewalk, lobby, or elevator, these areas must be controlled (e.g. elevators shut down or prevented from stopping on floors at which exposures are taking place). In addition, if exposure locations are near the walls of adjacent tenants, ensure the notification and evacuation of people within the 10 m radius. The 10 m radius applies to the camera floor and the floor directly below only. The qualified technician shall ensure adequate precautions for the additional floors above and below the camera floor.
- 3.1.5. Patch all openings after services have been installed to match the surrounding finishes.
 - 3.1.6. In existing areas all cutting, and core drilling for individual services except where specifically noted, is part of this division work.
 - 3.1.7. The cost of x-ray scanning, cutting, patching and finishing is included in this division contract.

END OF SECTION

26 09 13.01 Power Monitoring System – Web Based

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. SYSTEM DESCRIPTION

1.2.1. Furnish and install a complete Power Monitoring System (PMS) as detailed on the drawings and as described in this specification. The system is defined to include, but not be limited to, remote devices for monitoring, device communication interface hardware, inter-communication wiring and ancillary equipment. The manufacturer shall demonstrate the system is not a prototype and that similar systems have been field installed and successfully operated for at least five years.

1.2.2. The PMS shall interconnect all meters, electronic trip units, transformer temperature monitors, motor protection devices, and digital relays, included within the new power equipment and the existing devices shown on the drawings that have the capability to communicate through the network.

1.2.3. The PMS shall utilize Ethernet as the high-speed backbone network that supports view of all the information through a web-based interface.

1.2.4. All products shall not violate any U.S. or Canadian patents.

1.3. REFERENCES

1.3.1. All Power Meters and Circuit Monitors shall be UL 508 Listed, CSA approved, and have CE marking. They shall also have certified revenue accuracy as per ANSI C12.16.

1.3.2. The system shall comply with the applicable portions of NEMA standards. In addition, the control unit shall comply with FCC Emission Standards specified in Part 15, Sub-part J for Class A application.

1.4. SHOP DRAWINGS AND PRODUCT DATA

1.4.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4.2. Indicate electrical characteristics and connection requirements. When the power equipment manufacturer installs PMS components, the power equipment shop drawings shall clearly identify the components, the internal connections, and all contractor connections.

1.4.3. The PMS drawings shall show all PMS components including necessary component dimensions; type, size, and weight, as well as, a single line diagram indicating external wiring requirements. Drawings shall identify terminal blocks used for interconnections and wire type to be used.

1.4.4. Product Data: Provide catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.

1.4.5. Submit design of proposed web interface for review by the engineer's representative and the owner.

- 1.4.6. Submit to the engineer a calibration report confirming that the meters and Power Monitoring System have been calibrated based on the electrical system parameters at the project site. This calibration is to include site parameters such as voltage, CT Ratio, PT Ratio, and any other meter specific items.
- 1.5. QUALITY
 - 1.5.1. Power monitoring components included within the power equipment lineups shall be factory installed, wired and tested prior to shipment to the job site.
- 1.6. WARRANTY
 - 1.6.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 2. Products
 - 2.1. ADVANCED METER
 - 2.1.1. The Advanced Meter shall be installed as part of a power monitoring system as indicated on the drawings.
 - 2.1.2. The Advanced Meter shall communicate using MODBUS protocol over serial or TCP networks.
 - 2.1.3. The Advanced Meter shall include an integral Ethernet jack and shall include an embedded webpage. It shall also be capable to act as a gateways as part of the overall power monitoring system network.
 - 2.1.4. The Advanced Meter shall be a PowerLogic Power Meter PM5300 series or approved equal.
 - 2.1.5. The advanced meter shall be installed on the feeder circuits on the main switchgear as indicated and for the distribution panels as indicated on the drawings.
 - 2.2. POWER QUALITY METER
 - 2.2.1. The Power Quality Meter shall be installed as part of a power monitoring system as indicated on the drawings.
 - 2.2.2. The Power Quality Meter shall communicate using MODBUS protocol over serial or TCP networks.
 - 2.2.3. The Power Quality Meter shall include an integral Ethernet jack and shall include an embedded webpage. It shall also be capable to act as a gateways as part of the overall power monitoring system network.
 - 2.2.4. The Power Quality Meter shall be a PowerLogic ION 9000 or approved equal.
 - 2.2.5. Power quality meter shall be installed on the main breakers of normal switchboard/switchgear and on the main generator breaker.
 - 2.3. ETHERNET CONNECTIVITY AND WEB ENABLING
 - 2.3.1. Ethernet capability shall include an embedded web server inside the unit, capable of serving HTML pages with dynamic meter data displays and logging data.
 - 2.3.2. It shall be capable of accepting HTML files, PDF files, ActiveX CRG, GIF, JPG graphics, MS Office files (doc, xls, ppt, etc.).
 - 2.3.3. It shall feature one 10/100 Mbit UTP port.

- 2.3.4. It shall feature 16 MB of internal memory.
- 2.3.5. It shall support all meters and other MODBUS devices through one 2-wire or 4-wire RS-485 communication port via standard daisy-chain connections.
- 2.3.6. It shall feature one RS-485 serial port and a second port configurable for RS-232 or RS-485 (support for 2-wire or 4-wire).
- 2.3.7. It shall be assigned a single IP address, and provide high speed Ethernet support for up to 192 devices.
- 2.3.8. It shall be compatible with Ethernet TCP/IP networks and allows users to access power monitoring information from any location on a local area network (LAN) or a wide area network (WAN).
- 2.3.9. It shall also be possible via the Ethernet port to upgrade the firmware of the Ethernet communication card in the field to accommodate new system features.
- 2.4. EMBEDDED WEB PAGES
 - 2.4.1. Embedded WEB Pages shall be provided for any meter and any device connected to the main gateway meter. Where applicable to certain device types, the WEB pages shall include the following:
 - .1 Energy and Power Summary with Trending and Period Comparisons.
 - .2 Power Quality Summary with Trending and Comparisons.
 - .3 Harmonics and Power Flow Summary.
 - .4 Voltage Disturbance, Transient, and Flicker Summaries.
 - .5 Alarm Summary with Trending and Period Comparisons.
 - .6 ITIC/SEMI and Motor De-rating Curves.
 - .7 Real Time Trending with Forecasting.
 - .8 Real Time Energy Cost Summary Worksheet.
 - .9 EN50160 and IEEE519 Power Quality Index Tables, Trends and Summary Alarms.
- 2.5. COMMUNICATIONS TO THE BUILDING AUTOMATION SYSTEM
 - 2.5.1. Provide gateway to communicate to building automation system using Modbus RTU protocol to access metering data by building automation vendor.
- 2.6. MANUFACTURERS
 - 2.6.1. The PMS shall be:
 - .1 POWERLOGIC as manufactured by Schneider Electric.
 - .2 FORESEER as manufactured by Eaton.
 - .3 ACCESS as manufactured by Siemens.
 - .4 ABB.
- 3. Execution
 - 3.1. ETHERNET GATEWAYS
 - 3.1.1. Contractor interconnection wiring requirements shall be clearly identified on the PMS system drawings.

- 3.1.2. Advanced Ethernet gateways are to be used when meters and other components on the system do not contain internal memory.
- 3.1.3. Provide adequate internal memory to store historic data for a minimum of 30 days for all meters.
- 3.2. SYSTEM START-UP AND TRAINING
 - 3.2.1. On-site start-up and training of the PMS shall be included in the project bid.
 - 3.2.2. Start-up shall include a complete working demonstration of the PMS with simulation of possible operating conditions that may be encountered.
 - 3.2.3. Submit to the engineer a calibration report confirming that the meters and Power Monitoring System have been calibrated based on the electrical system parameters at the project site. This calibration is to include site parameters such as voltage, CT Ratio, PT Ratio, and any other meter specific items.
 - 3.2.4. Training shall include any documentation and hands-on exercises necessary to enable electrical operations personnel to assume full operating responsibility for the PMS after completion of the training period.
 - 3.2.5. The project bid shall include 2 days start-up assistance and 2 days training to include 3 separate trips.
- 3.3. DESIGN SERVICES
 - 3.3.1. The power monitoring system vendor shall make all alterations and changes needed to make the system perform as needed at each location. These changes may include:
 - .1 Custom enclosures and panels.
 - .2 Modifications to existing switchgear and equipment, including installation.
 - .3 Communication interface installation and configuration.
 - .4 Communication network design.
 - 3.3.2. The power monitoring system vendor to provide development, integration, and installation services required to complete and turn over a fully functional system, including but not limited to:
 - .1 All technical coordination, installation, integration and testing of all components.
 - .2 Detailed system design, including a full design of the proposed web interface in conjunction with the Owner and Engineer's Representative.
 - .3 System drawings.
- 3.4. INSTALLATION
 - 3.4.1. PMS components, including meters, electronic trip units, transformer temperature monitors, motor protection devices, and digital relays, included within the power equipment lineups shall be factory installed, wired and tested prior to shipment to the job site.
 - 3.4.2. All control power, CT, PT and data communications wire shall be factory wired and harnessed within the equipment enclosure.
 - 3.4.3. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.

3.5. WIRING

- 3.5.1. The electrical contractor shall install all wiring required to externally connect equipment lineups, external meters and any other wiring as required by the PMS vendor including all RS 485 communications network loops and Ethernet communications wiring to meters.
- 3.5.2. All wiring external to equipment is to be run in conduit.

END OF SECTION

26 09 24.00 Lighting Control Equipment – Addressable Low Voltage

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 51 13.00 – LIGHTING EQUIPMENT.
- 1.1.4. Lighting Control Sequence of Operations as attached to Specifications or as shown on drawings.

1.2. REFERENCES

- 1.2.1. CAN/CSA-C22.2 No. 141, Emergency Lighting Equipment, latest edition.
- 1.2.2. CAN/CSA-C22.2 No. 205, Signal Equipment, latest edition.
- 1.2.3. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
- 1.2.4. International Electrotechnical Commission (IEC)
- 1.2.5. National Electrical Manufacturers Association (NEMA)
- 1.2.6. Underwriters Laboratories, Inc. (UL)
- 1.2.7. UL 508 – Standard for Industrial Control Equipment
- 1.2.8. UL 916 – Standard for Energy Management Equipment
- 1.2.9. UL 924 – Standard for Emergency Lighting and Power Equipment

1.3. SUMMARY

- 1.3.1. This specification is intended to fully describe all of the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a building-wide networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.
- 1.3.2. Lighting Control System includes computer-based software that provides control, configuration, monitoring and reports. System includes the following components:
 - .1 Energy Control Unit
 - .2 System Server
 - .3 0-10 V Dimming, Fixed Output Ballasts or 0-10 V LED Drivers
 - .4 System Field Devices (Input and Output Modules)
 - .5 Occupancy Sensors – Low Voltage
 - .6 Photo Sensors – Low Voltage
 - .7 Wall stations – Low Voltage
 - .8 Lighting Control System Software - Graphical User Interface based
 - .9 Communication Wire
 - .10 Area Lighting Controllers and/or Room Controllers (to dim/switch a group of luminaires)
 - .11 Interface to Audio Visual equipment (for integration with 3rd party LCD Touch Screen Panel)

- .12 Interface to BACnet
- .13 Interface to customizable Energy dashboard

1.4. DESCRIPTION OF SYSTEM

- 1.4.1. The work covered in this section is subject to the requirements in the General Conditions of the Specifications. Contractor shall coordinate the work in this section with the trades covered in other sections of the specification to provide a complete and operable system.
- 1.4.2. Extent of the lighting control system work is indicated by drawings and by the requirements of this section. It is the intent of this section to provide an integrated, energy saving lighting control system as described herein from a single supplier. Contractor is responsible for confirming that all components and accessories of the lighting control system interoperate as a single system.
- 1.4.3. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the System Provider, as required to ensure proper system operation and maintainability.
- 1.4.4. The lighting control system shall include a fully distributed WAN/LAN network of global controller/routers, individually addressable System Field Devices that are not integral to luminaires, sensors, switches, relays and other ancillary devices required for a complete and operable system. The system WAN/LAN start-up shall be by the control system Manufacturer or Contractors certified by the Manufacturer.
- 1.4.5. The lighting control system shall utilize non-proprietary industry standard 0-10 V dimming or fixed output ballasts and/or 0-10 V LED drivers, occupancy sensors, daylight sensors, etc.
- 1.4.6. UL 924 listed devices shall have the ability to control 120 V / 277 V load.
- 1.4.7. System software interface shall have the ability to notify communication failures to system users via system & email messages. Email messages shall be available in html and text formats.
- 1.4.8. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
- 1.4.9. The electrical drawings may show a lighting control system designed with a specific manufacturer as a Basis of Design. There are pre-approved alternate manufacturers listed herein, which are acceptable lighting control systems to be used; however, by using pre-approved alternate manufacturers, the Contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring, etc. as required to suit the alternate pre-approved manufacturer's lighting control system. The Contractor shall provide complete engineered shop drawings (including power and control wiring) with deviations from the original design highlighted for review and approval prior to rough-in. Where additional components or devices are required to meet the same design intent as indicated in the drawings and specifications, the Contractor shall include for all costs.
- 1.5. LIGHTING CONTROL APPLICATIONS
 - 1.5.1. Provide a minimum application of lighting controls as follows:
 - .1 Space Control Requirements – Provide occupancy/vacancy sensors as shown and noted on the electrical drawings. Occupancy/vacancy sensors to provide Manual- or

- Partial-ON functionality or Automatic-ON as described in the drawings and specifications.
- .2 Bi-Level Lighting – Provide multi-level controls in all spaces as indicated in the electrical drawings and specifications.
 - .3 Task Lighting / Plug Loads – Where indicated on the drawings, provide automatic shut off of plug loads and task lighting. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.
 - .4 Daylit Areas – Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) and as indicated in the drawings, where daylight contribution is available. Daylighting control shall operate as follows:
 - .1 All luminaires within defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
 - .2 Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes and/or as indicated in the drawings and specifications.
 - .3 Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
 - .4 Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
- 1.5.2. All enclosed rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.
- 1.5.3. Sequence of operation by room type (including but not limit to):
- .1 Typical Office

The lights within the room would be controlled by a dimmable room controller, digital occupancy sensor, day light sensor and digital wall mounted dimming switch. Lighting would turn off via occupancy sensor or override off via wall mounted switch. In offices with a daylight sensor, each lighting zone within the room would be dimmed to separate levels based on day light sensor in order to maintain **minimum 30fc at desk level**. Day light sensor dimming shall be able to be overridden by digital wall mounted dimming switch. Coordinate with Owner the time period where all overridden loads will return to automatic daylighting control.
 - .2 Typical Classroom

The lights within the room would be controlled by a dimmable room controller, digital occupancy sensor, day light sensor and digital wall mounted dimming switch. Lighting would turn off via occupancy sensor or override off via wall mounted switch. In classrooms with a daylight sensor, each lighting zone within the room would be dimmed to separate levels based on day light sensor in order to maintain **minimum 35fc at desk level**. Day light sensor dimming shall be able to be overridden by digital wall mounted dimming switch. Coordinate with Owner the time period where all overridden loads will return to automatic daylighting control.
 - .3 Corridor

The lights within the corridor would be controlled by low voltage relay panel and occupancy sensors (refer to Section 26 09 24.00 Lighting Control Equipment – Low Voltage Panel). Lighting zones as indicated would turn on/off via occupancy sensor.

.4 Washrooms, Janitor Room, Photocopier Room and Storage Room

The lights within the room would be controlled by a line voltage wall mounted occupancy sensor with override switch. Lighting would turn off via occupancy sensor or override switch.

1.5.4.

1.6. SHOP DRAWINGS AND PRODUCT DATA

1.6.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.6.2. Submit manufacturer's data on lighting control system and components and the product data specified below at the same time as a package. Shop drawing submission shall include but not limited to the following:

- .1 Complete list of all parts needed to fully install selected system components.
- .2 Composite wiring and/or schematic diagram of each control circuit as proposed to be installed. Submitted shop drawings shall detail control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.
- .3 Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - .1 Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - .2 For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
 - .3 Show exact location of all digital devices, including at minimum sensors, load controllers, and switches for each area on reflected ceiling plans. Contractor must provide AutoCAD and PDF format reflected ceiling plans. For sensors, prove sensor is suitable for the proposed application.

1.6.3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.

1.6.4. Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades as required.

1.6.5. Software Operational Documentation:

- .1 Software operating and upgrade manuals
- .2 Program Software Backup: On portable memory storage device, USB stick, complete with data files.
- .3 Printout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities.

1.6.6. Catalog sheets, specifications and installation instructions.

1.6.7. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

- 1.6.8. Copy of applicable warranty.
- 1.6.9. Additional information as required on a project specific basis.
- 1.7. PROJECT CONDITIONS
 - 1.7.1. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - .1 Ambient temperature: 0° to 40° C (32° to 104° F).
 - .2 Relative humidity: Maximum 90 percent, non-condensing.
- 1.8. WARRANTY
 - 1.8.1. Provide a five year limited manufacturer's warranty on all equipment to be free of defects in materials and workmanship.
 - 1.8.2. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements shall be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
- 2. Products
 - 2.1. MATERIALS
 - 2.1.1. Control system: by one manufacturer and assembled from compatible components.
 - 2.2. CENTRAL LIGHTING CONTROL SOFTWARE
 - 2.2.1. The system shall offer central lighting control for the facility lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.
 - 2.2.2. Native central control software shall be utilized for energy reporting status and complete programming without the need for any third party hardware or software. Systems that require any third party linked software or graphics is not acceptable.
 - 2.2.3. Software shall provide information on general system settings via mouse click on a floor plan. Left clicking over a device on the graphical software interface shall show a description of the selected device/function attribute.
 - 2.2.4. The system shall provide an Interactive, Web-based graphical user interface (GUI) showing floor plans and lighting layouts that are native to the lighting control software. The only means required to program and operate the lighting control system shall be programmed and operated from a user interface that is based on a plan view graphical screen on the user's computer or the lighting control system's main computer. Shall include the navigational features listed below to allow for user's orientation within the controlled space, geographic heading and/or landmarks:
 - .1 Interactive;
 - .2 Vector based;
 - .3 Zoom;
 - .4 Rotate;
 - .5 Pan;
 - .6 Tilt.

- 2.2.5. The system shall allow the building operator to navigate through an entire facility both in two-dimensional and three-dimensional multi-floor view, allowing for fast and easy navigation.
- 2.2.6. Three-dimensional view shall exclude walls and other structural features to avoid shadowing and cluttering of the plan view.
- 2.2.7. Shall display multiple floors in single view resulting in easier system performance visualization for the entire site as well as individual zones or spaces.
- 2.2.8. The system shall allow system performance visualization across a portfolio of buildings via a single interface.
- 2.2.9. All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from this GUI. Editing shall be available from this GUI in a drag and drop format or from drop down menus without the need for any third party software. Systems that utilize or require third party linked graphics are unacceptable. The GUI shall continuously indicate the status of each connected device on the system and a warning indicator on the software if a device goes offline. Systems requiring spreadsheet editing for programming and that don't offer real time feedback are not acceptable.
- 2.2.10. Software settings and properties shall be selectable per individual device, room based, floor based or global building based.
- 2.2.11. Lighting Control Software interface shall provide current status and enable configuration of all system zones including selected individual luminaire availability, current light level, maximum light level, on/off status, occupancy status, and emergency mode (response to an emergency signal) status.
- 2.2.12. The system shall have the ability to display various lighting system parameters such as Lighting status (ON/OFF); Lighting levels, Load shedding status, or Lighting energy consumption, Occupancy status in a colorized gradient ("weather" map) type of graphical representation.
- 2.2.13. Energy Analysis data shall be exportable in CSV or image file formats.
- 2.2.14. The system shall allow import of native AutoCAD files.
- 2.2.15. Reporting feature shall be native to the lighting control software and capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:
 - .1 Energy consumption broken down by energy management strategy.
 - .2 Energy demand broken down by energy management strategy.
 - .3 Occupancy data by zone.
 - .4 Building wide occupancy status
 - .5 Time Schedule configuration status
 - .6 Lighting energy consumption in a color gradient ("weather map" type) view
 - .7 Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.
- 2.2.16. The software shall offer user configurable fade times (up to 86400 seconds) for individual or group of luminaire during transition between scenes.
- 2.2.17. The system shall be programmable for Time Clock Scheduling of lights on or off via the Lighting Control Software interface.

- 2.2.18. There shall be an "Emergency Mode", when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building emergency monitoring system at a convenient point and not require multiple connections.
- 2.2.19. All ballasts and/or drivers shall be centrally addressable, on a per luminaire or multiple luminaire/zone basis, through the Central Control Software. The basis of design shall utilize 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers connected to an Output Module. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of start-up or reconfiguration.
- 2.2.20. System shall be capable of operating independent of building's existing network infrastructure if desired and shall not rely on Tenant supplied PCs for operation.
- 2.2.21. Firewall Technologies & VLAN Configuration methods shall be utilized to separate tenants from the lighting control network and ensure the integrity of lighting control network.
- 2.2.22. The assignment of individual or group of system components to zones shall be performed via the Central Control Software such that physical rewiring will not be necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, ceiling tiles, etc. shall not be required.
- 2.2.23. Occupancy sensor time delays shall be configurable through software. Light level sensor parameters shall be configurable through software.
- 2.2.24. System shall auto-configure lighting controls for spaces that have been combined or divided temporarily by moving wall or similar systems.
- 2.2.25. System shall automatically lock wall stations and/or disable sensors based on one of the following system inputs: contact closure, a time schedule or the status of a monitored space.
- 2.2.26. The light management system shall be capable of interfacing digitally with a building automation system via BACnet/IP. The lighting control system shall be capable of communicating the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) to the BAS. Building Automation System shall utilize data from lighting control system input devices such as occupancy sensors to determine the status (occupied/unoccupied) of the mechanical control zones and perform climate adjustments accordingly.
- 2.3. DIGITAL WALLSTATIONS
- 2.3.1. The system shall connect with the wall stations via field bus that carry low voltage control signals.
- 2.3.2. Software configurable wall stations shall provide on/off switching and dimming control for up to six lighting zones/ five lighting scenes per wall station or more with allowable multi-gang configurations.
- 2.3.3. Shall allow manual dimming of light levels and override of the time schedule.
- 2.3.4. Scenes/zones in the system control software shall be synchronized with the buttons on the wall station.
- 2.3.5. All wall stations shall be individually addressable & reconfigurable via System Control Software.
- 2.3.6. All wall stations shall feature status LED's
- 2.3.7. All wall stations shall be Class 2 Low Voltage devices.
- 2.3.8. All wall stations power source will be from the communication bus.
- 2.3.9. Communication shall be via NEC/CEC Class 2 communication wire.

- 2.3.10. Wall station configuration shall be via GUI in a drag and drop format.
- 2.3.11. Custom button cap configuration shall allow combination of scene & zone in one wall station.
- 2.3.12. Custom commands shall be applied to individual wall station buttons.
- 2.3.13. Wall station shall display its current status (zone/scene under system control or OFF) when motion is detected in the close proximity of the wall station
- 2.3.14. The following User Interface and custom labelling options shall be available:
 - .1 Up to five (5) scene switching & dimming
 - .2 Up to six (6) zone switching
 - .3 One (1) zone switching
- 2.3.15. Shall allow vacancy sensor configuration.
- 2.3.16. Dimensions shall meet NEMA WD-6 spec.
- 2.3.17. The following mounting options shall be supported:
 - .1 Mount in standard size wall box
 - .2 On mounting brackets for low voltage devices
- 2.3.18. Shall be used with "Decorator" style wall plate.
- 2.4. SYSTEM FIELD DEVICES
 - 2.4.1. Shall provide a common interface to low voltage occupancy sensors and photo sensors via Input Modules. These modules shall automatically detect the type of devices they are connected to (i.e., photo sensor, occupancy sensor). Addresses to the field devices shall be assigned during system start-up. Upon establishing two way communication with the Energy Control Unit (ECU), these individually addressable modules shall enable each lighting component to be independently controlled and configured to best meet the needs of the facility. These modules shall connect directly to the NEC/CEC Class 2 communication bus.
 - 2.4.2. System Field Devices shall be individually addressable via System Control Software.
 - 2.4.3. System shall automatically address individual nodes during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
 - 2.4.4. Electrically rated for up to 24 VDC.
 - 2.4.5. Shall connect to NEC/CEC Class 2 communication wire.
 - 2.4.6. Shall retain all system settings in non-volatile memory.
 - 2.4.7. Suitable for fixture or junction box mounting in standard 1/2" knockout (7/8" dia.)
- 2.5. AREA LIGHTING CONTROLLER/ROOM CONTROLLER
 - 2.5.1. Shall provide a common interface (DIM/SWITCH) to a group of 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers via field bus that carry low voltage control signals.
 - 2.5.2. Area Lighting Controllers shall be addressable via Control Software.
 - 2.5.3. System shall automatically address individual area lighting controllers during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
 - 2.5.4. Electrical Maximum Load Ratings:
 - .1 20A 120-347 Vac Ballast
 - .2 20A 120-347 Vac Resistive
 - .3 20A 120-347 Vac Tungsten

- .4 20A 120-347 Vac General Purpose
- .5 1.5 HP 120-277 Vac Motor
- 2.5.5. Communication shall be via NEC/CEC Class 2 communication wire.
- 2.5.6. Control Options for:
 - .1 ON/OFF Switching
 - .2 Continuous 0-10V dimming
 - .3 Shall be able to communicate with 0-10V ballasts/drivers
- 2.5.7. Shall be used for general purpose plug load control.
- 2.5.8. Shall control up to 30 ballast/LED Drivers.
- 2.5.9. Shall retain all system settings in non-volatile memory.
- 2.5.10. Mechanically has mounting for standard 1/2" electrical box knockout.
- 2.5.11. Colour to be selected by Architect/Engineer's Representative.
- 2.5.12. UL916, UL924 & UL2043 listed.
- 2.6. DIGITAL DAYLIGHTING SENSORS
 - 2.6.1. Digital daylighting sensors shall work to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type.
 - 2.6.2. Daylighting sensors shall be interchangeable without the need for rewiring.
 - 2.6.3. The indoor sensor range shall be between 0 and 750 FC.
 - 2.6.4. The outdoor sensor range shall be between 0 and 750 FC.
 - 2.6.5. Atrium sensor range shall be from 2 to 2,500 FC.
 - 2.6.6. Skylight sensor range shall be between 10 and 7,500 FC.
 - 2.6.7. The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
 - 2.6.8. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
 - 2.6.9. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
 - 2.6.10. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
 - 2.6.11. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
- 2.7. DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR
 - 2.7.1. Wall or ceiling mounted (refer to drawings) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.
 - 2.7.2. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 - .1 Digital calibration and pushbutton configuration for the following variables:

- .1 Sensitivity – 0-100% in 10% increments
- .2 Time delay – 1-30 minutes in 1 minute increments
- .3 Test mode – Five second time delay
- .4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
- .5 Walk-through mode
- .2 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
- .3 Programmable control functionality including:
 - .1 Each sensor may be programmed to control specific loads within a local network.
 - .2 Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - .3 Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - .4 On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - .5 Ultrasonic and Passive Infrared
 - .6 Ultrasonic or Passive Infrared
 - .7 Ultrasonic only
 - .8 Passive Infrared only
 - .9 Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 - .4 Communication shall be via Class 2 communication bus.
 - .5 Manual override of controlled loads.
 - .6 All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
 - .7 Units shall not have any dip switches or potentiometers for field settings.
- 2.7.3. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required.
- 2.8. COMMUNICATION WIRE
 - 2.8.1. The system shall have the capability to use both NEC/CEC Class 1 and Class 2 wiring to integrate peripheral devices such as ballasts/LED drivers, occupancy sensors, photo sensors, relay-based controls, area lighting controllers, and wall stations into a complete, networked programmable lighting control system.
 - 2.8.2. Electrically uses NEC/CEC Class 2 Communication bus.
 - 2.8.3. Multi-conductor cable with stranded-copper conductors.
 - 2.8.4. Shall power photo sensors, PIR and dual-technology occupancy sensors.
 - 2.8.5. Shall allow random devices connection without the need for special network channel termination.
 - 2.8.6. Flame rated jacket for plenum use NFPA 262 (UL: FT6, CSA: CMP).

2.9. ENERGY CONTROL UNIT (ECU)

- 2.9.1. The Energy Control Unit (ECU) shall collect, process and distribute lighting control information to the system field devices and wall stations over NEC/CEC Class 2 communication bus. Each CU shall feature multiple NEC/CEC Class 2 communication channels that can control a large quantity of nodes (sensors, wall stations, 0-10V Dimming, Fixed Output Ballasts, 0-10V LED Drivers, etc.) per channel, per the manufacturers recommended maximum.
- 2.9.2. The ECU shall be the central intelligence point for the area it controls collecting signal information from sensors, wall stations and personal control software and determining appropriate brightness levels or on/off status for each luminaire or zone. The CU shall connect with a facility's or tenant's Local Area Network (LAN) via Ethernet to enable desktop personal control.
- 2.9.3. Ethernet communication ports that employ TCP/IP protocol shall be provided to simultaneously enable the following connections:
 - .1 Lighting Control Network
 - .2 Tenant LAN Access Point
- 2.9.4. Shall have 8 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting NEC/CEC Class 2 communication bus.
- 2.9.5. Each CU channel shall support up to 100 nodes or 800 nodes in total.
- 2.9.6. Shall have status LEDs for the following:
 - .1 Network activity on CU's Ethernet port/s
 - .2 CU channel status
 - .3 CU status
- 2.9.7. Shall enable the following functionalities:
 - .1 Backup to and Restore from USB flash drives
 - .2 Cycle lights through 100%, 25% & 0% steps
 - .3 Disable/enable all controller functionalities
 - .4 IP Address Reset
 - .5 Electronically deactivate individual channels
- 2.9.8. Shall have configuration stored in non-volatile flash memory.
- 2.9.9. Shall mount in a standard 19" rack (1U width), or alternatively where no rack is shown, via an individual wall mount.
- 2.9.10. UL916 and UL924 listed.

2.10. SYSTEM SERVER (SSU)

- 2.10.1. The System Server shall host the lighting control system database for all the lighting control devices. In addition, it shall provide remote accessing capability to change system settings and/or parameters.
- 2.10.2. Server shall have the ability to:
 - .1 Analyze system performance or energy data or generate system report;
 - .2 Record energy consumption with average sampling every 5 minutes for unlimited duration;
 - .3 Host the web interface required for the web enabled Personal Control Software or web based Central Control Software;
 - .4 Reside on a client server (virtual server);

- .5 Interconnect with Control Units over standard Ethernet connection that employs TCP/IP protocol;
 - 2.10.3. Each System Server shall have two Ethernet 10/100Base - Tx Cat 5 RJ45 ports that employ TCP/IP protocol.
 - 2.10.4. Shall mount in a standard 19" rack (1U width), or alternatively where no rack is shown, via an individual wall mount.
- 2.11. EMERGENCY LIGHTING CONTROL DEVICES
 - 2.11.1. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - .1 120/277 volts, 50/60 Hz, 20 amp ballast rating
 - .2 Push to test button
 - .3 Auxiliary contact for remote test or fire alarm system interface
- 2.12. MANUFACTURERS
 - 2.12.1. The following are acceptable manufacturers:
 - .1 Legrand– Encelium
 - .2 Cooper Lighting Solutions
 - .3 Lutron – Athena
 - .4 Acuity – nLight
 - .5 Crestron – Commercial Lighting Controls
- 3. Execution
 - 3.1. PRE-INSTALLATION MEETING
 - 3.1.1. A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:
 - .1 Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors.
 - .2 Review the specifications for low voltage control wiring and termination.
 - .3 Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 - .4 Discuss requirements for integration with other trades.
 - 3.2. INSTALLATION AND SERVICES
 - 3.2.1. Locate and install equipment in accordance with manufacturer's recommendations and as indicated.
 - 3.2.2. Install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.

- 3.2.3. Install all room/area devices using manufacturer's factory-tested cable with pre-terminated connectors. If pre-terminated cable is not used for room/area wiring, test each field-terminated cable following installation and supply the lighting controls manufacturer with test results. Contractor to install any room to room network devices using manufacturer-supplied network wire. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.
- 3.2.4. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication.
- 3.2.5. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
- .1 Adjust time delay so that controlled area remains lighted while occupied.
- 3.2.6. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
- .1 Sensor parameters, time delays, sensitivities, and daylighting setpoints.
- .2 Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
- .3 Load Parameters (e.g. blink warning, etc.)
- 3.2.7. Post start-up tuning – After 30 days from occupancy contractor shall adjust sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report to the Consultant/Owner of post start-up activity.
- 3.3. FACTORY SERVICES
- 3.3.1. Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system.
- 3.3.2. The Electrical Contractor shall provide both the manufacturer and the Consultant with three weeks written notice of the system start up and adjustment date.
- 3.3.3. Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.
- 3.4. SYSTEM START UP AND COMMISSIONING
- 3.4.1. If applicable, a commissioning agent will verify the installation and programming of all building systems, which includes the lighting control system. Manufacturer should include an extra day of technician's time to review the functionality and settings of the lighting control hardware with the commissioning agent, including reviewing submittal drawings and ensuring that instructions on how to configure each device are readily available. Manufacturer is NOT responsible for helping the commissioning agent inspect the individual devices. It will be the commissioning agent's responsibility to create and complete any forms required for the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the agent with this task.
- 3.4.2. The commissioning agent shall work with the electrical contractor during installation of the lighting control hardware to become familiar with the specific products. The agent may also accompany the manufacturer's technicians during their start-up work to better understand the process of testing, calibration and configuration of the products. However, the contractor and manufacturer shall ensure that interfacing with the agent does not prevent them from completing the requirements outlined in the contract documents.

3.5. TESTING

- 3.5.1. Upon completion of all line, load and interconnection wiring, and after all luminaire are installed and lamped, a qualified factory representative shall completely configure and test the system.
- 3.5.2. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

3.6. TRAINING

- 3.6.1. Provide four half days of training for the Owner and the Owner's maintenance staff on the operation and maintenance of the system.
- 3.6.2. Training to be recorded for use by Owner in the future.

END OF SECTION

26 12 17.00 Dry Type Transformers – 600V Primary

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 53.00 – IDENTIFICATION.

1.2. REFERENCE

1.2.1. CSA C22.2 No. 47, Air-Cooled Transformers (Dry-Type), latest edition.

1.2.2. CSA C802.2, Minimum Efficiency Values for Dry Type Transformers, latest edition.

1.2.3. U.S. Department of Energy (DOE) "DOE 2016 Efficiency", latest edition.

1.2.4. Natural Resource Canada Regulation SOR/2018-201 (NRCAN 2019), latest edition.

.1 Electricity Act, 1998 Regulation 509/18 Energy and Water Efficiency – Appliances and Products, latest edition.

1.2.5. CSA C9, Dry-Type Transformers, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4. STORAGE

1.4.1. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations. Store so condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable storage or service conditions.

1.4.2. Handle transformer using proper equipment for lifting and handling, use necessary lifting eye and/or brackets provided for that purpose.

1.5. WARRANTY

1.5.1. The transformer shall carry a 1 year warranty from the time of Substantial Performance of the Work.

2. Products

2.1. TRANSFORMERS

2.1.1. Use transformers of one manufacturer throughout project.

2.1.2. Design

.1 Type: ANN. All transformers to be delta-wye configuration unless otherwise noted on the drawings. Scott T constructed transformers will not be accepted.

.2 3 phase, kVA and voltages as indicated on the plans, 60 Hz.

- .3 Provide voltage taps of $2 \pm 2 \frac{1}{2} \%$ FCAN (full capacity above normal) & FCBN (full capacity below normal).
- .4 Insulation: Class 220 deg. C (former designation: Class H), 150 deg. C. or less temperature rise.
- .5 All windings are to be copper unless stated otherwise on the contract documents.
- .6 Basic Impulse Level (BIL): standard.
- .7 Hipot: standard.
- .8 Average sound level to comply with the latest edition of CSA C9 for the appropriate voltage class.
- .9 Impedance at 60 Hz: minimum impedance as shown in the table below.

Transformer size	Minimum impedance (%Z)
Up to 75 kVA	2.5 %
112.5 to 150 kVA	4 %
151 to 300 kVA	4 %
301 to 600 kVA	5 %
601 to 2500 kVA	6 %
Greater than 2500 kVA	Per CSA C9

- .10 Provide minimum K-4, K-rated transformers unless otherwise indicated on the drawings.
- .11 Enclosure: CSA Type 3R, removable metal front panel.
- .12 Mounting: floor or wall, as indicated.
- .13 Transformer to meet energy efficiency requirements of the energy efficiency standards referenced in this specification, whichever is more stringent, at 35% of rated load unless shown otherwise on drawings.
- .14 Finish: in accordance with Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2.2. ACCESSORIES

- 2.2.1. Provide analogue type winding temperature indicator with 2 sequence contacts for transformers of 225 kVA and larger. Provide sensor in the centre winding to monitor the temperature.
- 2.2.2. Grounding terminal: inside enclosure.
- 2.2.3. External vibration pads equal to Mason Super 'W'.
- 2.2.4. Nameplate shall be stainless steel.

2.3. EQUIPMENT IDENTIFICATION

- 2.3.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
- 2.3.2. Label size: 6 mm letters.

2.4. FINISH

2.4.1. Finish enclosure exterior in accordance with Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2.4.2. Transformer to be painted ANSI-61 grey.

2.5. MANUFACTURERS

2.5.1. The following are acceptable manufacturers:

- .1 Hammond Power Solutions
- .2 Delta Transformers
- .3 Schneider-Electric
- .4 Eaton Cutler-Hammer
- .5 Rex Power Magnetics
- .6 STI Power
- .7 Siemens
- .8 PowerSmiths Socomec Group
- .9 ABB

3. Execution

3.1. INSTALLATION

3.1.1. Mount dry type transformers as indicated. Transformers larger than 75kVA are to be floor mounted unless identified otherwise. Where a transformer larger than 75kVA is shown as mounted off the floor, the Contractor is to provide an engineered structure from the floor and wall to support the transformer. Structure to be stamped and signed by a professional engineer and submitted as a shop drawing. Design of structure to take into account the building structure within the respective room.

3.1.2. Provide external vibration isolation pads under transformer.

3.1.3. Ensure adequate clearance around transformer for ventilation. Install transformer to meet ventilation clearance requirements given by transformer manufacturer. Where transformer manufacturer does not have requirements, follow clearances required by the local electrical code.

3.1.4. Install transformers in level upright position.

3.1.5. Remove shipping supports only after transformer is installed and just before putting into service.

3.1.6. Loosen isolation pad bolts until no compression is visible.

3.1.7. Make primary and secondary connections with flexible conduit and in accordance with wiring diagram.

3.1.8. Energize transformers after installation is complete.

END OF SECTION

26 12 18.00 Harmonic Mitigating Dry Type Transformers

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 53.00 – IDENTIFICATION.

1.2. REFERENCE

1.2.1. CSA-C22.2 No. 47 – Air-Cooled Transformers (Dry Type), latest edition.

1.2.2. CSA C9 – Dry-Type Transformers, latest edition.

1.2.3. CSA-C802.2 - Minimum Efficiency Values for Dry Type Transformers, latest edition.

1.2.4. U.S. Department of Energy (DOE) “DOE 2016 Efficiency”, latest edition.

1.2.5. Natural Resource Canada Regulation SOR/2018-2001 (NRCAN 2019), latest edition.

1.2.6. Green Energy Act Ontario Regulation 404/12, latest edition

1.2.7. Electricity Act, 1998 Regulation 509/18 Energy and Water Efficiency – Appliances and Products, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4. STORAGE

1.4.1. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations. Store so condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable storage or service conditions.

1.4.2. Handle transformer using proper equipment for lifting and handling, use necessary lifting eye and/or brackets provided for that purpose.

1.5. WARRANTY

1.5.1. Warranty: 10 year pro-rated, with standard limited liability clauses, from the time of Substantial Performance of the Work.

2. Products

2.1. TRANSFORMERS

2.1.1. Use transformers of one manufacturer throughout project.

2.1.2. Design

- .1 3rd, 9th, & 15th harmonics and other zero sequence currents shall be treated within the secondary windings through cancellation of the zero sequence fluxes. Simply trapping these currents in the delta primary winding is NOT acceptable.
- .2 For 5th, 7th, 17th & 19th harmonics, provide the appropriate primary-secondary phase shift in order to cancel these harmonic currents with those of other loads fed from the same primary supply.
- .3 Harmonic mitigation shall be achieved by electromagnetic means only. No capacitors or electronics shall be used.
- .4 Evidence of relevant application experience must be available upon request.
- .5 Primary Voltage: As shown on drawings.
- .6 Secondary Voltage: As shown on drawings.
- .7 kVA rating: As shown on drawings.
- .8 System Frequency: 60 Hertz.
- .9 Positive & negative sequence impedance at 60 Hz: minimum impedance as shown in the table below.

Transformer size	Minimum impedance (%Z)
Up to 112.5 kVA	2.8 %
150 kVA	3.2 %
151 to 300 kVA	4 %
301 to 600 kVA	5 %
601 to 2500 kVA	6 %
Greater than 2500 kVA	Per CSA C9

- .10 Zero sequence impedance/reactance at 60Hz: Less than 1.0% and 0.5% respectively.
- .11 Load compatibility: K factor up to 20, Crest factor up to 4.5.
- .12 Neutral connection shall be rated at twice the ampacity of the secondary phase current.
- .13 Primary-secondary phase-shift at 5th and 7th harmonics: 0 deg. and -30 deg. for similar sized transformers fed from the same upstream panelboard or switchboard.
- .14 Three-phase, common core construction. Convection air cooled.
- .15 Copper Windings.
- .16 Insulation Class: 220 deg. C. system.
- .17 Temperature rise: 130 deg. C.
- .18 Transformer to meet energy efficiency requirements of the energy efficiency standards referenced in this specification, whichever is more stringent, at 35% of rated load unless shown otherwise on drawings.
- .19 Taps: 2 x ± 2.5 % (2FCAN, 2FCBN) for 75 - 300 kVA and 1 x ± 5 % for up to 45 kVA.
- .20 Sound level at 5 ft.: max. 45 dB up to 45 kVA, 50 dB from 75 to 150 kVA and 55 dB from 150 to 300 kVA.
- .21 Enclosure: ventilated, CSA type 3R enclosure.
- .22 Finish: ANSI 61 Grey.
- .23 Anti-vibration pads shall be used between the core and the enclosure.
- .24 UL listed and CSA approved.

- .25 Built to NEMA ST-20 and in accordance with all applicable UL, CSA and ANSI/IEEE standards.
- .26 Electrostatic shielding: [single: 60dB attenuation] [dual: 120dB attenuation].
- .27 Over-temperature alarm - wired to internal terminal strip.
 - .1 Contact (one per set point): normally closed [normally open].
 - .2 Set point: 180 deg. C.
- .28 Mounting: floor or wall, as indicated on the drawings.
- .29 Finish: in accordance with Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2.2. ACCESSORIES

- 2.2.1. Provide analogue type winding temperature indicator with 2 sequence contacts for transformers of 225 kVA and larger. Provide sensor in the centre winding to monitor the temperature. Wire alarm contacts to the Building Automation System.
- 2.2.2. Grounding terminal: inside enclosure.
- 2.2.3. External vibration pads equal to Mason Super 'W'.
- 2.2.4. Nameplate shall be stainless steel.

2.3. EQUIPMENT IDENTIFICATION

- 2.3.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
- 2.3.2. Label size: 6 mm letters.

2.4. ACCEPTABLE MANUFACTURERS

- 2.4.1. HARMONY-1™ transformer by MIRUS International Inc.
- 2.4.2. Sentinel H by Hammond Power Solutions Inc.
- 2.4.3. T1000 by PowerSmiths Socomec Group.
- 2.4.4. Distribution Transfilter by Power Quality International Inc.
- 2.4.5. Mitigator Series by Delta Transformers.
- 2.4.6. STI Power.

3. Execution

3.1. INSTALLATION

- 3.1.1. Mount dry type transformers as indicated. Transformers larger than 75kVA are to be floor mounted unless identified otherwise. Where a transformer larger than 75kVA is shown as mounted off the floor, the Contractor is to provide an engineered structure from the floor and wall to support the transformer. Structure to be stamped and signed by a professional engineer and submitted as a Shop Drawing. Design of structure to take into account the building structure within the respective room.
- 3.1.2. Provide external vibration isolation pads under transformer.
- 3.1.3. Ensure adequate clearance around transformer for ventilation. Install transformer to meet ventilation clearance requirements given by transformer manufacturer. Where transformer manufacturer does not have requirements, follow clearances required by the electrical code.

- 3.1.4. Install transformers in level upright position.
- 3.1.5. Remove shipping supports only after transformer is installed and just before putting into service.
- 3.1.6. Loosen isolation pad bolts until no compression is visible.
- 3.1.7. Make primary and secondary connections with flexible conduit and in accordance with wiring diagram.
- 3.1.8. Energize transformers after installation is complete.
- 3.1.9. Set transformer taps to produce rated secondary voltage, as shown on the drawings, at no load.

END OF SECTION

26 24 13.00 Switchboards

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 05 53.00 – IDENTIFICATION.
- 1.1.4. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.
- 1.1.5. Section 26 28 21.00 – MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS.
- 1.1.6. Section 26 28 14.00 – FUSES LOW VOLTAGE.

1.2. REFERENCE

- 1.2.1. CSA C22.2 No. 31 – Switchgear Assemblies, latest edition.
- 1.2.2. CSA C22.2 No. 244 – Switchboards (Trinational standard with UL 891 and NMJ-J-118/2-ANCE), latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.3.2. Indicate on Shop Drawings:
 - .1 Floor or wall anchoring method and foundation template.
 - .2 Dimensioned cable entry and exit locations.
 - .3 Dimensioned position and size of bus.
 - .4 Overall length, height and depth.
 - .5 Dimensioned layout of internal and front panel mounted components.
- 1.3.3. Include time-current characteristic curves for circuit breakers and fuses.
- 1.3.4. Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

1.4. MAINTENANCE DATA

- 1.4.1. Submit 3 copies of the maintenance data for the complete assembly including components, and include in the project operating and maintenance manuals.

1.5. MAINTENANCE MATERIALS

- 1.5.1. Include:
 - .1 Fuse or breaker types.

1.6. SOURCE QUALITY CONTROL

- 1.6.1. Submit 3 copies of certified test results, and include in the project operating and maintenance manuals.

1.7. WARRANTY

- 1.7.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. SWITCHBOARD

- 2.1.1. Ratings as identified on the drawings and/or schedules.
- 2.1.2. Switchboard and breakers / fused switches to have short circuit current rating as shown on the Drawings, and if not shown on the Drawings than with a minimum rating of 35 kA at 600 V.
- 2.1.3. Enclosures to be dead-front, CSA Type 1 with drip hood, sprinkler proof enclosure, size as indicated.
- 2.1.4. Hinged access panels with captive knurled thumb screws.
- 2.1.5. Bus bars and main connections: copper.
- 2.1.6. Bus from load terminals of main breaker via metering section to main lugs of distribution section.
- 2.1.7. Identify phases with colour coding.
- 2.1.8. Provide lugs that comply with the requirements of Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V. Size as per the Drawings.
- 2.1.9. Breakers and/or fuse sections shall be bolt-on.
- 2.1.10. Make provisions to extend the main bus to future cubicles on each end of the switchboard.
- 2.1.11. For Service Entrance Switchboards with secondary utility metering, provision for installation of power supply authority metering transformers in barriered section of switchboard, conforming to power supply authority requirements. Provide 1220 mm x 1220 mm x 305 mm (48 in. x 48 in. x 12 in.) wall mounted metering cabinet with plywood backboard for power authority use. Interconnect cabinet and instrument transformer compartment with 38 mm (1-1/2 in.) empty conduit.

2.2. CIRCUIT BREAKERS

- 2.2.1. Circuit breakers to be supplied as per Section 26 28 21.00 – MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS.
- 2.2.2. All breakers to be factory installed and tested.
- 2.2.3. Circuit breaker conductor terminations to be dual rated for Copper/Aluminum (Cu/Al).

2.3. FUSIBLE DISCONNECTS AND FUSES

- 2.3.1. Fusible horsepower rated disconnect switch sized as indicated.
- 2.3.2. Provision for padlocking in on-off position by three padlocks.
- 2.3.3. Mechanically interlocked door to prevent opening when handle is in the ON position.

- 2.3.4. Fuse: size as indicated, class J, current limiting in fuse holders without adapters. Fuses to be supplied as per Section 26 28 14.00 – FUSES LOW VOLTAGE.
- 2.3.5. Quick-make, quick-break action.
- 2.3.6. ON-OFF switch position indication on switch enclosure cover.
- 2.3.7. Fused Switch conductor terminations to be dual rated for Copper/Aluminum (Cu/Al).
- 2.4. GROUNDING
 - 2.4.1. Copper ground bus extending full width of cubicles and located at bottom.
 - 2.4.2. Size ground cable terminations as per the Drawings.
- 2.5. INFRARED WINDOWS
 - 2.5.1. Provide infrared windows in the switchboard main incoming section in sufficient sizes and quantities, to provide view of the main feeder terminations.
 - 2.5.2. The window lens shall be compatible with most popular IR cameras, fusion capable and shall transmit electromagnetic radiation in:
 - .1 Short, Mid and Long Wave Infrared
 - .2 Visual
 - .3 UVA and UVB Ultraviolet
 - 2.5.3. Label each window to provide the thermographer with full information necessary to properly set, and aim the infrared camera and correctly interpret readings. The information shall include but not be limited to:
 - .1 IR window location and number:
 - .2 Lens material, range and the effective wavelength:
 - .3 Lens Transmission Rate and proper compensation values:
 - .4 Target(s): name, location (in respect to window) and target(s) emissivity.
 - 2.5.4. Infrared windows shall be CSA approved to C22.2 No. 14 latest edition, UL/cUL listed, comply with IEEE Std. C37.20.2. Range, size, NEMA/IP and voltage rating suitable for the application. Infrared windows with plastic or polymer components shall also comply with UL746C.
 - 2.5.5. Acceptable manufacturers;
 - .1 Hawk IR International Limited / Fluke,
 - .2 FLIR,
 - .3 Lumasense Technologies Inc.
 - .4 IRISS Inc.
- 2.6. FINISHES
 - 2.6.1. Apply finishes in accordance with Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
 - 2.6.2. Switchboard to be painted: baked grey enamel.
- 2.7. EQUIPMENT IDENTIFICATION
 - 2.7.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
 - 2.7.2. Label all branch feeders with names as indicated on drawings.

2.8. FACTORY TESTING

- 2.8.1. Testing shall be witnessed by the Technical Services Division Startup Service Contractor.
- 2.8.2. Include in your bid for the complete cost of two people to attend the factory witness testing for the equipment. Cost to include but not limited to all travel, food and lodging costs.

2.9. MANUFACTURERS

- 2.9.1. The switchboards shall be manufactured by:
 - .1 Schneider Electric.
 - .2 Eaton Cutler-Hammer.
 - .3 Siemens.
 - .4 ABB.

3. Execution

3.1. INSTALLATION

- 3.1.1. Locate switchboard and secure in position.
- 3.1.2. Connect main incoming feeder to line terminals of main breaker, if applicable.
- 3.1.3. Connect load terminals of distribution switches or breakers to feeders.
- 3.1.4. Check factory made connections for mechanical security and electrical continuity.
- 3.1.5. Check trip unit settings and fuse sizes against co-ordination study to ensure proper working and protection of components.
- 3.1.6. For Service Entrance Switchboards only where a grounded conductor is installed from the exterior utility transformer (i.e. 4 wires only), provide system bonding jumper between neutral bus and ground bus.

3.2. TESTING

- 3.2.1. Contractor to review and test that all wiring has been connected as per the manufacturer drawings.
- 3.2.2. Switchboard to be tested on site as defined in Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE. Contractor to oversee all testing and correct any deficiencies noted.

END OF SECTION

26 24 17.00 Panelboards – Breaker Type

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 05 05.00 – MOUNTING HEIGHTS.
- 1.1.4. Section 26 05 53.00 – IDENTIFICATION.
- 1.1.5. Section 26 28 21.00 – MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS.

1.2. REFERENCES

- 1.2.1. CSA C22.2 No. 29 – Panelboards and Enclosed Panelboards, latest edition.
- 1.2.2. CSA C22.2 No. 5 – Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.3.2. Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
- 1.3.3. Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

1.4. WARRANTY

- 1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. PANELBOARDS

- 2.1.1. Panelboards: product of one manufacturer.
- 2.1.2. Install circuit breakers in panelboards before shipment.
- 2.1.3. In addition to CSA requirements, manufacturer's nameplate must show fault current that the panel including all breakers have been built to withstand.
- 2.1.4. Panelboards to have the following minimum ratings for interrupting capacity or as indicated on the drawings or panel schedules.
 - .1 120/208 V panelboards – 10 kA
 - .2 347/600 V panelboards – 22 kA

- 2.1.5. 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.
- 2.1.6. Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated. Provide an additional 20% of space within each panelboard in addition to what is shown on the drawings when a separate panel schedule is not provided for a specific panelboard.
- 2.1.7. Two keys for each panelboard and key panelboards alike.
- 2.1.8. Panelboards to be copper bus unless identified otherwise.
- 2.1.9. Where identified on the drawings or schedules, provide a neutral bus sized to 200 % of the mains rating for panels.
- 2.1.10. Mains: suitable for bolt-on breakers.
- 2.1.11. Trim with concealed front bolts and hinges, for all panelboards other than those used in residential suites.
- 2.1.12. Trim and door finish: baked grey enamel.
- 2.1.13. Enclosure to be CSA Type 1 with drip hood with the exception of recessed panel enclosures which are to be CSA Type 1.
- 2.1.14. Provide Surge Protection Device where shown on Drawings.
- 2.1.15. Series ratings aren't acceptable.
- 2.1.16. All lugs to be dual rated for Copper/Aluminum (Cu/Al).
- 2.1.17. Where panelboards shown on the Drawings are indicated as Power Panels (PPs) or Distribution Panels (DPs), provide panelboard models that by default accommodate a minimum of 3 feeder circuit breakers rated for a minimum of 200 A – 3P, in addition to those shown on the Drawings.
- 2.2. MOULDED CASE CIRCUIT BREAKERS
 - 2.2.1. Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg. C. ambient.
 - 2.2.2. Common-trip breakers: with single handle for multi-pole applications.
 - 2.2.3. Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.
 - 2.2.4. Main breaker, where indicated: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
 - 2.2.5. Lock-on devices for 10 % of 15 to 30 A breakers installed. Turn over unused lock-on devices to Owner.
 - 2.2.6. Where breakers are identified to feed high intensity discharge (HID) lighting, provide breakers that are rated and designed for use with HID lighting.
 - 2.2.7. Provide one breaker per designated breaker space. Multiple breakers contained in one housing or twin breakers are not acceptable.
 - 2.2.8. Breaker terminals to be dual rated for Copper/Aluminum (Cu/Al).
 - 2.2.9. Comply with Section 26 28 21.00 - MOULDED CASE AND INSULATED CASE CIRCUIT BREAKERS.

2.3. EQUIPMENT IDENTIFICATION

- 2.3.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
- 2.3.2. Complete circuit directory with typewritten legend showing location and load of each circuit.

2.4. MANUFACTURERS

- 2.4.1. The following are acceptable manufacturers:
 - .1 Schneider Electric
 - .2 Eaton Cutler-Hammer
 - .3 Siemens
 - .4 ABB

3. Execution

3.1. INSTALLATION

- 3.1.1. Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- 3.1.2. Install surface mounted panelboards on galvanized strut channel stand-offs or on fire rated plywood backboards. The plywood backboards are to be as per Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 3.1.3. Mount panelboards at height specified in Section 26 05 05.00 – MOUNTING HEIGHTS.
- 3.1.4. Connect loads to circuits.
- 3.1.5. Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

26 27 02.00 Surge Protective Device

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. STANDARDS

1.2.1. The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:

- .1 Institute of Electrical and Electronic Engineers (ANSI/IEEE), latest edition
 - .1 C62.11 Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV), C62.41.1 Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits, latest edition.
 - .2 C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits, latest edition.
 - .3 C62.45 Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits, latest edition.
- .2 Federal Information Processing Standards Publication 94 (FIPS PUB 94) – Guideline on Electrical Power for ADP Installations, latest edition.
- .3 National Fire Protection Association, latest edition:
 - .1 75 Standard for The Protection of Information Technology Equipment, latest edition.
 - .2 780 Standard for the Installation of Lightning Protection Systems, latest edition.
- .4 MIL Standard 220B Method of Insertion Loss Measurement, latest edition.
- .5 Underwriters Laboratories UL 1283 – Standard for Electromagnetic Interference Filters and UL 1449 – Standard for Surge Protective Devices, latest edition.
- .6 CSA C22.2 No. 269 Series – Surge protective devices, latest editions.
- .7 cUL.

1.3. OVERVIEW

1.3.1. The specifications in this section describe the electrical and mechanical requirements for a protection system provided by high-energy Surge Protective Devices (SPD) formerly called Transient Voltage Surge Suppressors (TVSS). The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B and C environments.

1.3.2. SPDs are designed for repeated limiting of transient voltage surges on 60 Hz Power circuits not exceeding 1000 V and designated as follows:

- .1 Type 2 – SPDs hard-wired to distribution equipment after the load side of the service equipment overcurrent device.
- .2 Type 3 – Plug-in SPDs.
- .3 Type 4 – Component SPDs and component assemblies.

1.4. ENVIRONMENTAL REQUIREMENTS

- 1.4.1. The operating temperature range shall be -25 deg. C. to 60 deg. C.
- 1.4.2. The unit shall be capable of operation up to 3,960 m above sea level.
- 1.4.3. No appreciable magnetic fields shall be generated.

1.5. SHOP DRAWINGS AND PRODUCT DATA

- 1.5.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.5.2. Product Data: Provide catalogue sheets and supporting documentation showing:
 - .1 System voltage.
 - .2 UL1449 listing.
 - .3 UL 1449 Voltage Protection Ratings.
 - .4 UL 1449 I-n rating.
 - .5 Dimensions showing construction, lifting and support points, and enclosure details.
 - .6 Per mode and per phase peak surge current ratings.
 - .7 Modes of discrete suppression circuitry.
 - .8 Warranty period and replacement terms.
 - .9 Conductor size, conductor type, and recommended lead length.
 - .10 SPD is suitable for the application including system grounding configuration.
- 1.5.3. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Indicate maximum size of circuit breaker or fuse to be connected for each unit.
- 1.5.4. List and detail all protection systems such as fuses, disconnecting means and protective features.
- 1.5.5. Provide verification that the SPD device complies with the required UL1449 latest edition, latest revision, and CSA or cUL approvals.
- 1.5.6. SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -40 dB at 100 kHz.
- 1.5.7. For retrofit and side-mounting applications, provide electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- 1.5.8. Operation and maintenance manuals shall include details for each SPD shipped.
- 1.6. DELIVERY, STORAGE AND HANDLING
 - 1.6.1. Equipment shall be handled and stored in accordance with manufacturer's written instructions. One (1) copy of manufacturer's written instructions shall be included with the equipment at time of shipment.
- 1.7. QUALITY ASSURANCE AND WARRANTY
 - 1.7.1. The manufacturer shall provide a full ten (10) year warranty from the date of Substantial Performance of the Work.

2. Product

2.1. GENERAL

- 2.1.1. The SPD shall be listed by CSA or cUL to UL's 1283 and UL's 1449 standards, and not merely the components or modules. Listing must be verified by a third party approved laboratory.
- 2.1.2. The SPD shall be CSA or cUL/UL 1449 labelled with 200 kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD.
- 2.1.3. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over-temperature controls. SPDs relying upon external or supplementary installed safety disconnect do not meet the intent of this specification.
- 2.1.4. Obtain all surge suppression devices from a single manufacturer.
- 2.1.5. The maximum continuous operating voltage (MCOV) of all components for solidly grounded systems shall not be less than 125 % for a 120 V system and 120 % for 220 and 240 V systems, and 125 % for 347 and 600 V systems. All components for resistance grounded systems shall have an MCOV not less than 125 % of the line-to-line voltage.
- 2.1.6. Provide delta connected SPDs where a resistance grounded system is shown on the Drawings.
- 2.1.7. All SPD's shall be equipped with a comprehensive monitoring system which shall include a visual panel display providing information on unit status and phase loss/protection loss.
- 2.1.8. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
- 2.1.9. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
- 2.1.10. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

Configuration	Protection Modes			
	L-N	L-G	L-L	N-G
Wye	•	•	•	•
Delta	N/A	•	•	N/A
Single Split Phase	•	•	•	•
High Leg Delta	•	•	•	•

- 2.1.11. The SPD shall protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N and N-G, and have bidirectional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable. In delta systems, line-to-ground-to-line protection is not acceptable where line-to-line is specified.
- 2.1.12. Nominal Discharge Current (In) – All SPDs applied to the distribution system shall have a 20 kA In rating regardless of their SPD Type (includes Types 2 and 4) or operating voltage. SPD shall be UL 1449 labelled with this kA I-nominal (I-n) rating.
- 2.1.13. ANSI/UL 1449 Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	2500

- 2.1.14. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations or distribution equipment rated at 1,000 Amps or more.	300 kA	150 kA
B	Distribution equipment rated less than 1,000 Amps but greater than 400 Amps	200 kA	100 kA
A	Branch Location Panelboards, MCCs, Busway rated at 400 Amps or less	100 kA	50 kA

- 2.1.15. Internal Fusing - Overcurrent Protection

.1 Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over-temperature controls. SPDs relying upon external or supplementary installed safety disconnect do not meet the intent of this specification.

- 2.1.16. SPD shall be separate from or integral to the electrical equipment. Where an Integral SPD is supplied, unit shall be UL 1449 labelled as Type 1 intended for Type 2 applications without need for external or supplemental overcurrent controls.

- 2.1.17. The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability.

- 2.1.18. SPD lugs and terminals shall be dual rated for Copper/Aluminum (Cu/Al).

2.2. CATEGORY C LOCATIONS

- 2.2.1. Provide SPD on the service entrance equipment or distribution equipment rated at 1,000 Amps or more.

- 2.2.2. The SPD shall have an internal audible alarm with mute on front cover.

- 2.2.3. SPD's for service entrance locations shall have a transient event counter with LCD panel display and reset button on the front cover.

2.3. CATEGORY B LOCATIONS

- 2.3.1. SPDs for distribution equipment rated less than 1,000 Amps but greater than 400 Amps shall be as indicated on project Drawings.

- 2.3.2. The SPD shall have an internal audible alarm.

2.4. CATEGORY A LOCATIONS

- 2.4.1. SPDs for the branch location panelboards, MCCs, busway rated at 400 Amps or less shall be as indicated on project drawings and panel schedules.

- 2.4.2. The SPD shall have an internal audible alarm.

2.5. DATA & SIGNAL LINE PROTECTION (FOR 24 V APPLICATIONS)

- 2.5.1. The unit shall have a data transmission rate up to 10.0 Mbps.

- 2.5.2. Each conductor shall have less than 2.4 ohm of internal series resistance per wire, and each pair of conductors shall have a peak surge current of no less than 10,000 amps per wire (20,000 amps per pair), 8 x 20 μ s waveform.
- 2.5.3. SPD Voltage Protection level shall be less than < 46 V.
- 2.5.4. The response time of the components of the unit shall be less than one nanosecond.
- 2.6. PHONE LINE PROTECTION
 - 2.6.1. The unit shall be listed under UL 497A, Standard for Secondary Protectors for Communications Circuits.
 - 2.6.2. The unit shall have a data transmission rate up to 16.0Mbps.
 - 2.6.3. Each conductor shall have less than 1 ohm of internal series resistance per wire.
 - 2.6.4. Each pair of conductors shall have a peak surge current of no less than 200 amps, 8 x 20 μ s waveform.
 - 2.6.5. The maximum let-through voltage on an IEC 10 x 700 μ s impulse (2kV/80A) shall be 260 volts tip-ring, 260 volts tip to ground, and 260 volts ring to ground.
 - 2.6.6. The response time of the components of the unit shall be less than one nanosecond.
- 2.7. ENCLOSURES
 - 2.7.1. All enclosed equipment shall have CSA Type 1 with drip hood, sprinkler proof enclosure, unless otherwise noted.
 - 2.7.2. For integral mounted SPD unit, it should be mounted in separate compartment with separate removable cover. For remote mounted SPD unit provide separate enclosure mounted as near to the electrical equipment as possible.
- 2.8. MANUFACTURERS
 - 2.8.1. Approved Vendors:
 - .1 Eaton Cutler-Hammer
 - .2 Innosys Power Inc.
 - .3 Schneider Electric
 - .4 Siemens
 - .5 Surge-Pure
 - .6 ABB
 - .7 Mersen
 - .8 Citel
- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Install the SPD with the conductors as short and straight as practically possible. Gently twist conductors together. SPD performance is drastically reduced with increased conductor length.
 - 3.1.2. Installer shall reasonably rearrange breaker locations to minimize the lead length to SPDs.

- 3.1.3. Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. The Electrical Contractor shall ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.
- 3.1.4. Main service entrance units shall be installed on a breaker, or, where indicated, shall be installed on a fused disconnect switch that meets or exceeds the fault current rating of the switchgear. Size of breaker to be confirmed by manufacturer and coordinated with distribution equipment supplier.
- 3.1.5. Distribution, branch panel, and motor control center units shall be installed on dedicated circuit breakers. Size of breaker to be confirmed by manufacturer and coordinated with distribution equipment supplier. A 3-pole breaker position shall be provided for connection of SPD.
- 3.1.6. The installing contractor shall comply with all applicable codes.

END OF SECTION

26 27 13.00 Electronic Metering

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 34.00 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.

1.1.4. Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.

1.1.5. Section 26 09 13.01 – POWER MONITORING SYSTEM – WEB BASED.

1.2. STANDARDS

1.2.1. Except as noted by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the Canadian Electrical Manufacturer's Association, CSA and Measurement Canada.

1.2.2. The system shall be bench certified/approved by Measurement Canada for legal trade under the "Electricity and Gas Act" of Canada.

1.2.3. At the completion of installation, the system shall be field reviewed to verify compliance with Measurement Canada Specifications.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.3.2. Submit shop drawings and manufacturers data for the component items shown and specified under this section of the specification. This shall include, but not limited to:

- .1 System riser, one line and installation diagrams.
- .2 Manufacturer's system and communications connection diagram.
- .3 Information on selected reporting software.
- .4 All electrical and mechanical meters.
- .5 All final verification and acceptance forms/letters.

1.3.3. Do not supply any equipment to this project prior to shop drawing review by the Engineer's Representative.

1.3.4. Shop drawings will be stamped and signed by the Electrical Contractor prior to submittal, allow a minimum of one week for review of the shop drawings submitted.

1.3.5. At the completion of the Project, As-Built Drawings will be submitted by the Submetering Supplier/Manufacturer and Electrical Contractor, who will prepare a complete manufacturer's manual including but not limited to all as-built wiring diagrams and all required Measurement Canada certifications and test results.

1.4. DESCRIPTION OF SYSTEM

1.4.1. Work under this section is subject to the requirements of Section 26 05 01.00 - GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

- 1.4.2. Provide a fully digital utility (i.e. electricity, water, gas, heating and cooling energy) measurement system for multi-tenant buildings incorporating complete metering. The mechanical meters and electrical metering panel(s) must have its own local display for reading the meters connected to it.
- 1.4.3. All utility consumption metering on site shall be supplied and coordinated through the Submetering Supplier and Electrical Contractor. Consumption metering for all utilities on site must be coordinated through the Submetering Supplier and Electrical Contractor to:
 - .1 Ensure metering infrastructure meets all applicable regulatory requirements.
 - .2 Is capable of seamlessly integrating to the chosen end user platform.
 - .3 Allow for necessary tenant billing data criteria.
 - .4 Ensure non-proprietary data protocols.
 - .5 Allow for one point of contact for all stakeholders.
- 1.4.4. Submetering System to collect data on Electricity, Gas, Water and Heating and Cooling energy consumption. Meters to communicate data to central point(s) and be remotely accessible by operations team, accounting, etc., using a web-based data collection and reporting software.
- 1.4.5. System to include:
 - .1 Meter Hardware - Electrical
 - .2 Meter Hardware - Heating Energy Meters
 - .3 Meter Hardware - Cooling Energy Meters
 - .4 Meter Hardware - Water
 - .5 Meter Hardware - Gas
 - .6 Communications Infrastructure
 - .7 Data Collection and Reporting
 - .8 Execution and Verification
- 1.4.6. The submetering system shall be scalable to include other utility metering, including the power metering system on the Main 600 V Switchboard. System shall be used for tenant billing, and/or energy management.
- 1.4.7. Provide computerized metering in accordance with the Contract Documents. The system to come complete with all parts necessary to operate this system.
- 1.4.8. Remote sub-metering panels shall be used for electricity consumption and display in a digital format and in real numbers.
- 1.4.9. All electricity submetering units to be mounted in a CSA Type 1 with drip hood, sprinkler proof enclosure either located next to the electrical panel(s).
- 1.4.10. Metering panels communicate over their own network, which can report to remote computers using telephone or Ethernet/WAN/Internet communications.
- 1.5. WARRANTY
- 1.5.1. All meters shall have a manufacturer's warranty of 3 years.
- 1.5.2. All other equipment shall be free from defect in materials and workmanship under normal use and service for the period of twenty four (24) months from the date of Substantial Performance of the Work.

2. Products

2.1. ELECTRICAL METERS/METERING AND SUBMETERING EQUIPMENT

- 2.1.1. The electricity meter system will be used to monitor key house electrical loads and riser disconnects on each tenant floor and optional metering for select tenant 120/208 plug loads fed within the building.
- 2.1.2. All meters to be Measurement Canada approved and their installation to be verified and commissioned as per Measurement Canada S-E-04 standards.
- 2.1.3. Meters to have Ethernet interface for direct connection to building's central fibre communications network.
- 2.1.4. Each multi-meter includes current transformers, potential transformers (if applicable), cable connections and Ethernet and BACnet IP capabilities. Meters must have BTL listing (BACnet Testing Laboratories).
- 2.1.5. All electrical meters must be tested, sealed and verified to Measurement Canada standards (no exceptions). Verification of meter installation on-site to comply with Measurement Canada S-E-04 inspection procedures.
- 2.1.6. Meters must be capable of directly metering North American 120/208 V, 120/240 V, 240/416 V, and 277/480 V and 347/600 V wye services. Meters may use manufacturer specified and supplied Potential Transformers for the higher voltages, if required.
 - .1 The Potential transformers, if required, shall be mounted in a separate enclosure rated for the size and capacity necessary to feed the number of meters shown as per the drawings and rated by the manufacturer. Potential transformers must be Measurement Canada approved for revenue metering (independently or as part of system approval).
 - .2 Potential transformers shall be factory assembled and come complete with electrical disconnects and fuses mounted in a separate enclosure.
- 2.1.7. Metering Units must have the capability of a single incoming cable with associated current transformers (CT's).
- 2.1.8. Must meet all ISO 9001 standards for quality control where all meters test to a minimum of +/- 0.5% accuracy.
- 2.1.9. Operating Frequency: 50/60 Hz.
- 2.1.10. Power Factor Range: 0.5 to 1.0 lead/lag.
- 2.1.11. Operating Temperature Range: -40 degrees to +55 degrees C.
- 2.1.12. Current Ranges: 100/200/400 Amps or 5/10 Amp interface (services over 400 A or critical loads)
- 2.1.13. Metering unit(s) must be able to meter a minimum of 24 single-pole circuits, 12 single phase/Network meters and 8 three phase type meters.
- 2.1.14. Meter communications options: Ethernet, Modbus TCP, BACnet or modem:
 - .1 Ethernet interface at each metering device
 - .2 Meters must be a push IP based communication
 - .3 There cannot be any modifications to customer's existing firewall
 - .4 Modbus TCP or BACnet communications for interface to client systems
- 2.1.15. Meters and their elements must conform to the Measurement Canada "Standard Drawings for Electrical Metering Installations" to ensure accurate metering. All configurations shall come with current transformers/transducers required in the "Standard Drawings".
- 2.1.16. Approved Electrical Submeter Manufacturers:

- .1 Triacta Powerhawk 6X12 Series multi-meter.
- .2 Carma Industries.

2.2. HEATING AND COOLING ENERGY (BTU) SUB-METERING EQUIPMENT

2.2.1. Meter must be EN1434 Certified.

2.2.2. Components: each thermal meter system includes ultra-sonic flow meter, two pocket-type temperature sensors, sensor wells and thermal energy calculator.

2.2.3. Temperature sensors: pocket-type thermal sensors are required; direct immersion sensors will not be accepted. One of the temperature sensors and its well shall be located in the ultrasonic flow meter housing. Temperature sensors must be PT500 or better.

2.2.4. Flow Meter: Ultrasonic flow meter to have R value of 200 or better. Flow meter must be able to operate in up to 50% glycol composition and up to 120 Degrees C. Base meter size on nominal flow rate.

2.2.5. Combined heating/cooling: the heating thermal meter must also be capable of measuring cooling energy if the meter is used in a combined heating and cooling two-pipe system. And vice versa, the cooling thermal meter must also be capable of measuring heating energy if the meter is used in a combined heating and cooling two-pipe system.

2.2.6. Accuracy: thermal meter system to meet or exceed Accuracy standard EN 1434 for energy metering. Refer to Measuring Instrument Directive (MID) MI-004

2.2.7. Communications: The meters must be capable of M-BUS or equal remote communications and will be connected to the M-Bus or equal network in the property.

2.2.8. Power: The thermal meters will be powered by the M-Bus network or equal and contain a minimum 10 year back-up battery. Primary power through a battery or separate electrical connection will not be accepted.

2.2.9. Display: Meters to be complete with a Liquid Crystal Display (LCD) to access all measurements (flow, temperatures, energy, system status). Meters without displays will not be accepted

2.2.10. Calculator Location: thermal calculator can be mounted on top or side of meter or be wall mounted

2.2.11. Labeling: meter labeling to include meter name, Q3 (Qn) flow value, type examination certification number, Metrology Identification (serial #), manufactured year, temperature class, maximum pressure, pulse ratio, and indication of vertical or horizontal installation

2.2.12. Data Logging: calculator to store at least 1000 events, up to 18 monthly end kWh values, and peak flow, temperature, and kWh values

2.2.13. Pulse Inputs: thermal meter to be capable of receiving at least two pulse inputs from other utility meters

2.2.14. Pulse Outputs: thermal meter must be capable of providing two pulse outputs for energy and volume

2.2.15. Alarming: meter system to log and report via M-Bus system or equal failures or alerts. Meter must include alarming for temperature sensor failure, maximum/minimum temperature exceeded, maximum flow exceeded, air in line.

2.2.16. Security: at the completion of commissioning, the meter's protective devices shall be sealed by representatives of the competent authority. For any subsequent adjustment of the meter or for replacement of sub-assemblies, batteries etc., it will thus be necessary to break one or more seals. Seals shall be renewed in accordance with appropriate regulations.

2.2.17. Approved Thermal (BTU) Meter Manufacturers:

- .1 GWF UltraMaxxV series
- .2 GWF CF5X series
- .3 Or approved equal

2.3. DOMESTIC WATER SUBMETERING EQUIPMENT (COLD AND HOT WATER)

- 2.3.1. Components: each water meter includes single jet meter, 8 digit register, GWF M-Bus register encoder or equal and two NPSM to NPT connectors.
- 2.3.2. Accuracy: consumption meter to meet or exceed Accuracy standard EN 14154 or AWWA standard C712-02, ANSI/NSF 61 and NIST 44-2006 Section 3.36 for water metering and have a minimum R value of 80. Refer to Measuring Instrument Directive (MID) MI-001.
- 2.3.3. Communications: The meters must be capable of M-BUS or equal remote communications and will be connected to the M-Bus or equal network in the property.
- 2.3.4. Power: The water meters shall not require external power or will be powered by the M-Bus network or equal.
- 2.3.5. Display: Meters to be complete with 8 digit register, showing measurement down to 1 litre resolution.
- 2.3.6. Labeling: meter labeling to include meter name, Q3 (Qn) flow value, type examination certification number, Metrology Identification (serial #), manufactured year, temperature class, maximum pressure, pulse ratio, and indication of vertical or horizontal installation. Meter to also be colour-coded to reflect cold (blue), warm (orange) or hot (red) water applications.
- 2.3.7. Security: at the completion of commissioning, the meter's protective devices shall be sealed by representatives of the competent authority. For any subsequent adjustment of the meter or for replacement of sub-assemblies, batteries etc., it will thus be necessary to break one or more seals. Seals shall be renewed in accordance with appropriate regulations.
- 2.3.8. Approved Water Meter Manufacturers:
 - .1 GWF Unicocoder MP single jet meters with M-Bus communications. For installations over 1", use GWF MTKcoder or Woltman Delta meters.
 - .2 Or approved equal.

2.4. NATURAL GAS SUBMETERING EQUIPMENT

- 2.4.1. Each meter includes rotary or diaphragm meter and pulse output communications module
- 2.4.2. The meters must include pulse output for connection to Data Collector, M-Bus network or electricity meter.
- 2.4.3. All gas meters used for metering tenant loads must be tested, sealed and verified to Measurement Canada standards (no exceptions).
- 2.4.4. Approved Gas Meter Manufacturers:
 - .1 Roots Dresser natural gas meters
 - .2 Elster natural gas meters
 - .3 Or approved equal

2.5. M-BUS COMMUNICATIONS INFRASTRUCTURE – MECHANICAL METERS

- 2.5.1. All mechanical meters (water, gas and thermal) shall communicate M-Bus or equal to a central collection point(s) using:

- .1 M-Bus meter bus communications system, consisting of an M-Bus Master and meters with M-Bus Interface. Meters and Master connected by network of twisted pair copper cables.
- .2 Master: M-Bus Master is a Level Converter CMe3100 with capacity extension modules available; up to 250 slave meters can be read from each CMe3100 master
- .3 External Communications: CMe3100 is Ethernet enabled and will require a static IP with internet access
- .4 Power: 120VAC power source is required for the CMe3100 and extension modules
- .5 Baud Rate: standard set at 2400
- .6 Protocol: slave protocol to include 'header' information (primary address, secondary address [serial 3], meter type, manufacturer, etc.) and 'read' information (consumption values), as per standard EN 1454-3
- .7 Configuration Software: M-Bus system to be configured with non-proprietary M-Bus software, such as MBConf

2.5.2. The Basis of Design for the mechanical meters communications system is M-Bus. If the Submetering Supplier does not offer M-Bus communication for their mechanical meters, an alternate communications system may be considered by the Engineer's Representative/Owner upon written approval and the following:

- .1 Must be a bus based network compatible with daisy-chain or 'star' topology and transmitting absolute encoded register reading.
- .2 Shall submit all information pertaining to the alternate system to the Engineer's Representative/Owner for review/approval. The Submetering Supplier and Electrical Contractor may be required to submit additional information of the alternate communication system upon request by the Engineer's Representative/Owner if the original submission is considered insufficient or inadequate for proper review.
- .3 The Submetering Supplier and Electrical Contractor shall be responsible for any and all labor and material costs associated with changes using the alternate communications system. This shall include, but not limited to, additional power connections, metering panels, conduit, wiring, cabling, terminations, etc. to suit the requirements of the alternate communications system. No additional costs shall be considered by the Owner arising from miscoordination related to acceptance of this alternate system.

2.6. DATA COLLECTION, REPORTING, BILLING AND SYSTEM SOFTWARE

2.6.1. All meter data must be collected via the communication infrastructure and reported through one or more of the following software options. At a minimum, 15 minute interval kWh data must be available for download into a CSV, Excel file.

2.6.2. The following capabilities and services must be provided:

- .1 Web-hosted Energy Reporting Software:
 - .1 Provide QMC MeterConnex web-based reporting software or approved equal. Graphing and exportation of meter data shall be available on-line. Tenant interface shall also be available, provided as a Software as a Service with no upfront costs
- .2 BAS and Power Quality Meter Integration:
 - .1 Seamlessly integrate meter register data for meters pertaining to building operations and/or maintenance. This shall include communicating and fully integrating the Submetering System with information from the Power Quality Meters installed on the Main 600 V Switchboard of the building. Electrical

- Contractor to coordinate communications protocol with Power Quality Meters supplied as specified in Section 26 09 13.01 - Power Quality Metering System.
- .3 The Submetering Supplier must have the following capabilities as an option for their system:
- .1 Tenant Billing Services:
- .1 Read all meter data on a monthly basis and produce tenant invoices for electricity, heating and cooling energy and domestic water use. Billing summary shall be capable of being sent to property or tenant directly.
- .2 Shall provide menu driven generation of energy bills in a format similar to the format provided by the local Utility Supplier. Shall permit energy cost calculations that utilizes information from account bill received from the local Utility Supplier, allowing for the incorporation of co-incident demand charges and time of use rates allocated to each tenant.
- .3 Shall permit multiple metering points to be allocated to a single tenant file in order to totalize a number of metering points and energy costs to a single tenant account.
- .4 Shall permit reconfiguration of tenant accounts through menu selection.
- .5 Shall list all tenant accounts including the tenant history file.
- .6 Shall access the actual metering measurements used in deriving each Tenant's invoice.
- .7 Provide billing data within a format compatible with standard accounting packages.
- .2 This service shall be provided on an ongoing basis and negotiated with the Owner/Property Manager at completion of system installation.
- .4 The Submetering System Software shall meet the following requirements:
- .1 Must be accessible by any user via standard web-browser, such as IE, Chrome, etc.
- .2 Also provide a Windows™ based simplified user interface for system operation.
- .3 Tiered access so users can only access meter data and reports selected by system owner.
- .4 Up to 100 user accounts available.
- .5 Multiple utilities must be presented, including electricity, water, gas and thermal energy.
- .6 Environment Canada weather data must be collected (Heating and Cooling Degree Days, Average Temperature).
- .7 Metering data must be available to other software parties via API (Application Program Interface).
- .8 All data must be exportable in CSV or Excel format.
- .9 Mandatory Functionality:
- .1 Bill Generation, including utility consumption and rates.
- .2 Visual Reports, including 15 minute energy profiles, load comparisons.
- .3 Heat Mapping Tool.
- .4 Weather Regression modelling based on HDD/CDD or average temperature.
- .5 Alarming tools: demand or consumption min and max thresholds and automated email or text alarm to selected users.

- .6 Automated reporting tool: automated PDF report sent to selected users showing energy-related KPIs (Key Performance Indicators) of property.
- .7 Revenue legal metering measurements shall be received from all sub-metering sensors and stored in a central Data Collection Unit (DCU).
- .8 To monitor, acknowledge and control communications with the remote metering points and to log any disruption of the communication link or unauthorized system access or tampering.
- .9 To permit the user to view instantaneous readings of voltage, current, power, phase angle, present and peak demand for any electricity meter.
- .10 To permit the user to view instantaneous readings present usage (totalized) or demand (last 15 minute interval) for any mechanical meter.
- .11 Provide the ability to export data into Reporting Applications (e.g. Web and Excel VBA).
- .12 To include service menus for diagnostic monitoring of the metering equipment and through either a modem and telephone link or Internet access to permit remote diagnostics by the manufacturer's service technicians. Security access control shall permit remote diagnosis to be locked out.

2.7. WIRING

- 2.7.1. Provide all wiring in conduit as required to operate the entire system. Wiring to be provided as per manufacturer's instructions. All power wiring to be in conformance with the electrical code.

3. Execution

3.1. DRAWING REVIEW

- 3.1.1. Submetering Supplier and Electrical Contractor to review tenant electrical, gas, heating, cooling and domestic water distribution using construction contract drawings to coordinate and budget all meters and M-Bus communications system according to site-specific distribution and property needs. This includes both the Electrical and Mechanical Contract Drawings.

3.2. MECHANICAL METER INSTALLATION

- 3.2.1. The Electrical Contractor shall supply and turn over all mechanical meters to the Mechanical Contractor for installation in the piping system. All meters to include two isolation shutoff valves.
- 3.2.2. Wiring of mechanical meters to connect to the Submetering System to be supplied and installed by the Electrical Contractor. Coordinate exact locations and installation on site with the Mechanical Contractor.

3.3. ELECTRICAL METER INSTALLATION

- 3.3.1. All metering equipment shall be installed in electrical or mechanical rooms, as indicated on the drawings.
- 3.3.2. Remove electrical panel cover.
- 3.3.3. Wire bending space should be in compliance with Canadian Electrical Code Section 12. Verify that Current Transformers, Power Taps, and wiring can be installed without crowding the electrical panel.

- 3.3.4. Verify that the Current Transformers can be installed with a minimum 1/2 inch clearance to uninsulated live parts in panel, and without bearing against dead metal parts.
- 3.3.5. Verify that power is 120V, 120/280V, 120/240V, 240/416V or 416V, 277/480V, 480V, 347/600V or 600V. Verify that neutral is available if applicable.
- 3.3.6. Provide a dedicated 15A, 120VAC circuit for each panel and equipment from the nearest available panel. Provide a new breaker in the respective panel.
- 3.3.7. Verify that the meter is the right size and voltage for the installation.
- 3.3.8. Secure metal conduit to panel. Use insulating bushing. Reliable grounding is required. Locknuts must be tightened enough to pierce paint in cabinet.
- 3.3.9. Secure meter enclosure in or on wall, according to location, and connect conduit using locknut. Attach the enclosure to a wall stud using screws to provide equivalent support.
- 3.3.10. Install CT's and PT's per manufacturer's recommendations.
- 3.3.11. Interconnect all metering panels with wiring in conduit as per manufacturer's instructions. Provide connection of Metering Panels to remote accesses connection: telephone, Ethernet connection, etc.
- 3.3.12. Replace electrical panel covers.
- 3.3.13. Contact Electrical Safety representatives for verification of compliance to governing electrical codes.
- 3.3.14. All electrical multi-meters must be verified according to Measurement Canada S-E-04 inspection procedures.
- 3.3.15. Contact Measurement Canada or accredited service provider for installation verification. Installation verification shall include a tenant-to-breaker check. Electrical Contractor must be available for verification support.
- 3.4. CALIBRATION AND MAINTENANCE SERVICE
 - 3.4.1. All meters shall be Measurement Canada bench verified, and Submetering Supplier will provide all Inspection/Verification Certificates within as-built documentation in order to provide a complete operational system.
 - 3.4.2. Submetering Supplier will include all required Measurement Canada installation inspections in pricing. All appropriate equipment is to be labelled with the respective certification labels.
 - 3.4.3. Electrical Contractor to provide "AS BUILT" – marked up by Submetering Supplier; "Record of Metering Installation" sheet(s) indicating each meter, serial no., address, cross reference, metered tenant(s) and other applicable information. Information to be forwarded to software or reporting vender.
 - 3.4.4. The Submetering Supplier shall verify, adjust and test the system. Verification to be carried out with the assistance of the Electrical and Mechanical Contractor. Upon completion, Submetering Supplier to issue a "CERTIFICATE OF ACCEPTANCE" to the Engineer's Representative/Owner, and Electrical Contractor. This shall be submitted as a Shop Drawing to the Consultants and incorporated into the final O&M Manuals.
 - 3.4.5. Submetering Supplier shall demonstrate operation of the system as follows:
 - .1 Meter readings at the meter
 - .2 Diagnostics
 - .3 Provide manual of installed system.
 - 3.4.6. The Submetering Supplier shall provide pricing for billing services, on a per meter price, for collection of tenant sub-metered energy for return to building management or local distribution company (LCD) to apply against facility energy costs.

- 3.4.7. The Submetering Supplier shall detail remote connectivity requirements (telephone, High-Speed Internet, etc.). Building owner/property manager shall provide necessary remote connectivity to allow for remote billing services, if required.
- 3.4.8. Submetering Supplier to register the system with Measurement Canada and work with the Owner to obtain all required information to do so.
- 3.4.9. After the specified Measurement Canada approval period (seal period typically 6 years), the Submetering Supplier shall provide options for maintaining Measurement Canada Approval. This may include, but not limited to: Onsite Re-verification or removal of existing equipment and replacement with Measurement Canada verified equipment.
- 3.4.10. The Submetering Supplier shall provide pricing to the Owner for system maintenance, repair and/or replacement service to the extent that is covered by the warranty.
- 3.5. COMMUNICATIONS
 - 3.5.1. Provide a dedicated IP connection at point of central data collection for remote meter reading and diagnostics of the system.
- 3.6. TRAINING
 - 3.6.1. Submetering Supplier to provide 4 hour training and software manual for Owner's staff of selected reporting system.

END OF SECTION

26 27 19.00 Multi-Outlet Assemblies

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 27 26.00 – WIRING DEVICES.

1.1.4. Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.

1.2. REFERENCE

1.2.1. CSA C22.2 No. 62 – Surface Metal Raceways, latest edition.

1.2.2. ANSI/TIA 569-C – Commercial Building Standard for Telecommunications Pathways and Spaces, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.3.2. If variations from the reviewed shop drawings occur during the installation of the system, final as built drawings shall be submitted for each floor that has been altered.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. SURFACE RACEWAY FOR WIRING DEVICES

2.1.1. The raceway and all system components must be CSA listed.

2.1.2. Raceway to be constructed of galvanized steel unless stainless steel is identified on the drawings. Raceway base shall have a minimum thickness of 1.3 mm (0.050 in.) and the cover shall have a minimum thickness of 1 mm (0.040 in.).

2.1.3. Raceways shall be painted with the colour to be determined by the architect at the time of shop drawing stage. Submit available colour selections with the shop drawing submittal.

2.1.4. The raceway shall have a minimum of two compartments unless additional compartments are identified on the drawings. Assembled base and cover shall be a 120 mm (4¾ in.) wide for two section raceway and additional 60 mm (2-3/8 in.) for every additional compartment with a minimum depth of 45 mm (1¾ in.) unless specified otherwise on the drawing.

- 2.1.5. The raceway shall be a modular design with separate covers for each compartment divided with fixed barriers. The compartment covers to be snap on design, which snap side by side on a common base. Raceway covers shall be enhanced tamper resistant form, where screws are only necessary on access plates and the covers of certain fittings, but not on standard cover lengths. A tool shall be provided to form the shape in the cover flange necessary to maintain enhanced tamper resistance when the cover is field cut. Another tool shall be provided for cutting covers to ensure square field cuts.
- 2.1.6. Provide all required fittings including, but not limited to flat, internal and external elbows, couplings for joining raceway sections, wire clips, blank end fittings, entrance fittings, and a full complement of device mounting brackets and plates. All fittings shall be an enhanced tamper resistant form and shall be divided with barriers and made to match the size of the accompanying raceway base.
- 2.1.7. Provide full capacity corner elbows and tee fittings to maintain a controlled 50 mm (2 in.) cable bend radius, which meets the specifications for Fiber Optic cabling and exceeds the TIA 569 requirements for communications pathways.
- 2.1.8. Device brackets shall be provided in sizes to match the width of the raceway and with mounting-holes appropriately located to ensure proper mounting of devices in all compartments.
- 2.1.9. Device plates shall be made in any length from 152.4 mm (6 in.) to 1.5 m (60 in.) with cut outs to accommodate various combinations of power and/or communication devices in all compartments. Device plates shall be 152.4 mm (6 in.) and 304.8 mm (12 in.) long with a flange to overlap the joint of the adjacent cover. Provide 5% additional device plates for future additions or modifications for all types of devices installed.
- 2.2. MANUFACTURERS
- 2.2.1. The following are approved manufacturers:
- .1 CER - Canadian Electric Raceways.
 - .2 Legrand – Wiremold.
 - .3 Hubbell.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Prior to and during installation, refer to system layout or approval drawings containing all elements of the system. Installer shall comply with detailed manufacturer's instruction sheets, which accompany system components, as well as complete system instruction sheets, whichever is applicable.
- 3.1.2. All raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, also in accordance with manufacturer's installation sheets.
- 3.1.3. All metal raceway shall be electrically continuous and bonded in accordance with the respective electrical code for proper grounding.
- 3.1.4. Provide a separate insulated bonding conductor in the entire length of the raceway.
- 3.1.5. Raceway shall be securely supported at intervals not exceeding 1500 mm (5 ft.) or in accordance with manufacturer's installation sheets.

- 3.1.6. All raceway systems shall be installed complete, including insulating bushings and inserts where required by manufacturer's installation sheets. All unused raceway openings shall be closed.
- 3.1.7. Locate wireway and wiring devices as shown.
- 3.1.8. Install supports, elbows, tees, connectors and fittings. Keep the number of elbows, offsets and connections to a minimum.
- 3.1.9. Install wiring and wiring devices as indicated.
- 3.1.10. Install barriers to separate different wiring systems.

END OF SECTION

26 27 26.00 Wiring Devices

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 05.00 – MOUNTING HEIGHTS.

1.1.4. Section 26 05 53.00 – IDENTIFICATION.

1.1.5. Section 26 51 13.00 – LIGHTING EQUIPMENT.

1.2. REFERENCES

1.2.1. CSA C22.2 No. 42, General use receptacles, attachment plugs, and similar wiring devices, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. SWITCHES

2.1.1. 20 A, single pole, double pole, three-way, or four-way specification grade switches. Voltage rating of the switch to be as per the contract documents.

2.1.2. Manually-operated general purpose switches with following features:

- .1 Terminal-holes approved for No. 10 AWG wire.
- .2 Silver alloy contacts.
- .3 Urea or melamine moulding for parts subject to carbon tracking.
- .4 Suitable for back and side wiring.
- .5 Decora Style specification grade Rocker switch.
- .6 Colour to be selected by Architect/Engineer's Representative.

2.1.3. Toggle operated locking fully rated for tungsten filament and fluorescent lamps, and up to 80 % of rated capacity of motor loads.

2.2. RECEPTACLES

2.2.1. All receptacles to be specification grade.

2.2.2. Duplex receptacles, Decora style CSA Type 5-15 R, 125 V, 15 A, U ground, with following features:

- .1 Thermoplastic with impact-resistant nylon face moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Eight back wired entrances, four side wiring screws.
 - .4 Triple wipe contacts and riveted grounding contacts.
- 2.2.3. Duplex receptacles with USB charging outlets, Decora style CSA Type 5-15 R, 125 V, 15 A, U ground, with following features:
- .1 Thermoplastic with impact-resistant nylon face moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Six back wired entrances, four side wiring screws.
 - .4 Triple wipe contacts and riveted grounding contacts.
 - .5 One USB A charging outlet and one USB C charging outlet, 5 V DC, 6 A shared between the two ports.
- 2.2.4. Single receptacles CSA Type 5-15 R, 125 V, 15 A, U ground with following features:
- .1 Thermoplastic moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Four back wired entrances, 2 side wiring screws.
- 2.2.5. Other receptacles with ampacity and voltage as indicated.
- 2.2.6. Receptacles to be coloured as follows:
- .1 Normal Power – Colour to be selected by Architect/Engineer's Representative.
 - .2 Emergency/Essential Power – Red.
 - .3 Isolated Ground – Orange.
 - .4 Switched – Gray.
 - .5 UPS – Blue.
- 2.2.7. All dwelling receptacles of CSA configuration 5-15R and 5-20R shall be tamper resistant receptacles and shall be so marked; receptacles dedicated for microwaves, refrigerators, freezers or those receptacles located in an attic or crawl space shall not be required to be tamper-resistant.
- 2.2.8. All dwelling receptacles rated 125 V, 20 A or less shall be provided with arc-fault protection, except for the following:
- .1 Bathroom and washroom basin receptacles.
 - .2 Kitchen counter receptacles
 - .3 Refrigerator receptacles
- 2.2.9. Arc-fault protection for dwelling unit receptacles shall be provided by:
- .1 A combination-type arc-fault circuit interrupter
 - .2 An outlet branch-circuit interrupter installed at the first outlet on the branch circuit, where the wiring method for the portion of branch circuit between the branch circuit overcurrent device and the first outlet consists of metal raceway, armoured cable, or non-metallic conduit or tubing.
- 2.2.10. Electrical Contractor shall coordinate with furniture supplier to identify switched circuits prior to installation.

2.3. MANUFACTURERS

2.3.1. The switches and wiring devices shall be of one manufacturer throughout the project.

2.3.2. The following are acceptable manufacturers:

- .1 Legrand.
- .2 Hubbell.
- .3 Cooper.
- .4 Leviton.

2.4. DIMMERS

2.4.1. Dimmers shall be 600 W, 1500 W, 2000 W.

- .1 Full range, continuously variable control of light intensity.
- .2 Vertical slider allowing the light level to be set by the user.
- .3 Slide to Off.
- .4 Capable of operating at rated capacity.
- .5 Power failure memory.
- .6 Dimmers shall be available for direct control of incandescent, magnetic low voltage, electronic low voltage, fluorescent, and LED.

2.4.2. Electronic (solid-state) Low Voltage (ELV) transformer dimmers (incandescent).

- .1 Circuitry designed to control the input of Electronic (solid state) Low Voltage transformers.
- .2 Control up to 600 W of Electronic Low Voltage load.
- .3 Reset-able overload protection when capacity is exceeded.

2.4.3. LED dimmers.

- .1 Slide to Off only. Must match driver and LED requirements.

2.4.4. Manufacturers

- .1 Lutron Maestro Series.
- .2 Leviton True Touch Series.

2.5. SPECIAL WIRING DEVICES

2.5.1. Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic lens flush type.

2.6. COVER PLATES

2.6.1. Cover plates for wiring devices.

2.6.2. Cover plates from one manufacturer throughout project.

2.6.3. Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

2.6.4. Provide stainless steel cover plates, suitable for the respective device, for all devices mounted in flush-mounted outlet boxes located in finished areas.

2.6.5. Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

2.6.6. Weatherproof rain tight while-in-use metal cover, complete with gaskets for duplex receptacles located outside or as indicated.

- 2.6.7. Weatherproof rain tight while-in-use metal cover, complete with gaskets for single receptacles or switches located outside or as indicated.

3. Execution

3.1. INSTALLATION

3.1.1. 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 Where line voltage controls are used, install an identified conductor at each location of a manual or automatic control device in accordance with electrical code requirements.
- .4 Mount toggle switches at height specified in Section 26 05 05.00 – MOUNTING HEIGHTS or as indicated.

3.1.2. Receptacles:

- .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
- .2 Mount receptacles at height specified in Section 26 05 05.00 – MOUNTING HEIGHTS or as indicated.
- .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.

3.1.3. Dimmers:

- .1 Install dimmers as indicated. Provide suitable clearances in multi-gang boxes as recommended by the manufacturer to maintain the dimmer rating.
- .2 Coordinate the dimmer selection with the ballast/driver to be controlled, to ensure compatibility.
- .3 Where line voltage controls are used, install an identified conductor at each location of a manual or automatic control device in accordance with electrical code requirements.

3.1.4. Cover plates:

- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .2 Install suitable common cover plates where wiring devices are grouped.
- .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.1.5. Labelling

- .1 Provide labels with panel name and circuit number on all receptacles in conformance with Section 26 05 53.00 – IDENTIFICATION.

END OF SECTION

26 28 21.00 Moulded Case and Insulated Case Circuit Breakers

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. CSA C22.2 No. 5 – Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS

1.3.2. Include time-current characteristic curves for breakers with ampacity of 400 A and over or with interrupting capacity of 22,000 A symmetrical (RMS) and over at system voltage.

1.3.3. Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. BREAKERS GENERAL

2.1.1. Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg. C. ambient.

2.1.2. Common-trip breakers: with single handle for multi-pole applications.

2.1.3. Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

2.1.4. Circuit breakers with interchangeable trips as indicated.

2.1.5. Where a circuit breaker shown on the Drawings is rated 1200 A or higher, provide the following:

.1 Energy reducing maintenance switching (ERMS) system that provides a means to reduce arcing fault clearing time, with the following features:

.1 Positive feedback status indication LED light to indicate the status of the system, built into the equipment housing the breaker.

- .2 A selector switch to turn the system on and off, built into the equipment housing the breaker.
- .3 A selector switch to be located remote from the equipment and a 24 V DC circuit, to turn the system on and off.
- .4 Ability for circuit breaker trip unit to have two trip curves – the first for normal operation and the second for when a qualified person is working within the arc flash boundary (maintenance mode).
- .5 Ability for second trip curve to be set so that the breaker operates faster and more sensitively.
- .6 Pickup settings as low as 2.5 times breaker rating plug.
- .7 Provide system with documentation and equipment lamacoids that explain how the system works.

2.2. THERMAL MAGNETIC BREAKERS

- 2.2.1. Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3. MAGNETIC BREAKERS

- 2.3.1. Moulded case circuit breakers to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4. FUSED THERMAL MAGNETIC BREAKERS

- 2.4.1. Fused thermal magnetic breakers with current limiting fuses internally mounted. Time current limiting characteristics of fuses coordinated with time current tripping characteristics of circuit breaker. Coordination to result in interruption by breaker of fault-level currents up to interrupting capacity of breaker. Fuses individually removable and interlocked with breaker. The removal of fuse cover, blowing of a fuse or removal of a fuse, shall trip the breaker.

2.5. SOLID STATE TRIP BREAKERS

- 2.5.1. Circuit breaker to operate by means of an adjustable solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition.
- 2.5.2. Electronic trip with true RMS sensing.
- 2.5.3. Use current transformers to ensure accurate measurement from low current up to high currents.
- 2.5.4. Electronic trip with thermal memory/imaging.
- 2.5.5. Adjustable solid state trip unit complete with:
 - .1 Adjustable long time pick-up
 - .2 Adjustable long time delay
 - .3 Adjustable short time pick-up (where S indicated on Drawings)
 - .4 Adjustable short time delay (where S indicated on Drawings)
 - .5 Adjustable instantaneous pick-up (where I indicated on Drawings)
 - .6 Adjustable ground fault pick-up (where G indicated on Drawings)
 - .7 Adjustable ground fault delay (where G indicated on Drawings)

- .8 Long time, short time, instantaneous tripping for phase and ground fault short circuit protection as noted above.
- 2.5.6. Trip unit consisting of adjustable protection settings set by rotating switch or digital keypad, and rating plug.
- 2.5.7. Provide features listed below:
 - .1 For breakers rated less than 1200 A:
 - .1 Comply with the requirements for breakers rated 1200 A and above in the "Breakers General" section above.
 - .2 Provide trip unit with local trip indication and ability to locally and remotely indicate reason for trip (e.g. overload, short circuit, or ground fault).
- 2.6. INSULATED CASE CIRCUIT BREAKERS GENERAL
- 2.6.1. Use insulated case circuit breakers where shown on the Drawings.
- 2.6.2. Provide draw out type electrically operated circuit breaker with remote open/close key switch.
- 2.6.3. Provide circuit breaker operating mechanisms that are two-step, fully-stored energy devices for quick-make, quick-break operation with a maximum of a five-cycle closing time. Open-close-open (O-C-O) cycle possible without recharging. Provide motor operator that automatically charges when circuit breaker is closed. Charge the closing springs (step one) upon actuation of the operating handle or an operation cycle of the circuit breaker motor and close the circuit breaker contact (step two) upon operation of a local "close" button. Automatically charge the opening springs when closing the circuit breaker contacts.
- 2.6.4. Provide breaker that is 100 % continuous current rated in its enclosure.
- 2.6.5. Provide kirk keys where indicated on the Drawings.
- 2.6.6. Completely isolate current-carrying components from the accessory mounting area and double insulate current-carrying components from the operator with accessory cover in place.
- 2.6.7. Provide padlocking provisions furnished to receive up to three padlocks when circuit breaker is in the open position, positively preventing unauthorized closing of the circuit breaker contacts.
- 2.6.8. Provide provisions for up to two key locks allowing locking in the disconnected position. Provide provisions for locking in the connected, test and disconnected positions by padlock or key lock.
- 2.6.9. Provide buttons, with lockable clear cover, located on the face of the circuit breaker, to open and close the circuit breaker and indicators to show the position of the circuit breaker contacts, status of the closing springs, and circuit breaker position in the cell. Provide an indicator that shows "charged-not OK to close" if closing springs are charged but circuit breaker is not ready to close. Provide circuit breaker racking system that has positive stops at the connected, test, disconnected and withdrawn positions.
- 2.6.10. Equip circuit breaker with an interlock to discharge the stored energy spring before the circuit breaker can be withdrawn from its cell. Provide circuit breaker that provides a positive ground contact check between the circuit breaker and cell when the accessory cover is removed while the circuit breaker is in the connected, test or disconnected positions.
- 2.6.11. Provide interlocks to prevent circuit breaker draw out when in closed position and to prevent closing unless fully engaged or in test position. Provide breaker that is trip free during racking operation.
- 2.6.12. Provide as an option, primary connectors that can be rotated to provide flexible vertical or horizontal connections. Ensure front connections are available as an option for shallow depth equipment designs.

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- 2.6.13. Provide ready-to-close contact that indicates remotely that the circuit breaker is "ready to close." The circuit breaker is ready to close when it is open, spring mechanism is charged, a maintained closing order is not present, a maintained opening order is not present, and the circuit breaker is in an operational position.
- 2.6.14. Provide secondary control wiring that is front accessible and available in cage clamp or ring terminal connections. Provide secondary wiring that is inaccessible when switchboard door is closed.
- 2.6.15. Provide long service life circuit breaker. Provide circuit breakers certified to perform a minimum of 10,000 operations without maintenance where circuit breaker frames are 3000 A and below.
- 2.6.16. Equip circuit breaker with a visual contact wear indicator.
- 2.6.17. Provide circuit breaker arc chutes that don't contain asbestos.
- 2.6.18. Trip Unit
- .1 Comply with the requirements noted above in the Solid State Trip Breakers section.
 - .2 Provide trip units that are removable to allow for field upgrades.
 - .3 Provide trip units that are capable of the following types of ground-fault protection: residual, zero sequence, source ground return, and modified differential. Ground-fault sensing systems may be changed in the field.
 - .4 Ensure neutral current transformers are available for four-wire systems.
 - .5 Provide trip units that have real time metering and metering functions that include current, voltage, power and frequency. Provide metering accuracy of 1.5 % current, 0.5 % voltage, and 2 % power. Accuracies listed are total system including CT and meter and are of reading, not full scale, in a range of 5 – 500 %.
 - .6 Provide trip unit with provisions for communications on a network.
- 2.7. ACCESSORIES
- 2.7.1. Include:
- .1 shunt trip, when electrically operated or when indicated.
 - .2 auxiliary switches, when electrically operated or when indicated.
 - .3 motor-operated mechanism, when electrical operation indicated.
 - .4 on-off locking device.
 - .5 handle mechanism.
 - .6 Where a breaker serves a fire pump, the breaker is to come complete with auxiliary contacts that are to be monitored by the fire alarm system.
- 2.8. MANUFACTURERS
- 2.8.1. The following are acceptable manufacturers:
- .1 Schneider Electric
 - .2 Eaton Cutler-Hammer
 - .3 Siemens
 - .4 ABB

3. Execution

3.1. INSTALLATION

3.1.1. Install circuit breakers as indicated.

3.1.2. Contractor to wire any neutral CT's to the breaker trip unit where required by the breaker ground fault detection system or as otherwise required by the manufacturers instructions.

END OF SECTION

26 28 23.00 Disconnect Switches – Fused and Non-Fused

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 53.00 – IDENTIFICATION.

1.2. REFERENCE

1.2.1. CSA C22.2 No. 4 – Enclosed Switches, latest edition.

1.2.2. CSA C22.2 No. 39 – Fuse-holder Assemblies, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.3.2. Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

1.4. WARRANTY

1.4.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. DISCONNECT SWITCHES

2.1.1. Fusible, horsepower rated disconnect switch in CSA Type 3R enclosure, size as indicated.

2.1.2. Non-fusible, horsepower rated disconnect switch in CSA Type 3R enclosure, with minimum 10 kA Short Circuit Current Rating (SCCR), with manufacturer listed series rating with upstream breaker / fuse where available fault current exceeds 10 kA and with UL series rating label on disconnect switch, size as indicated.

2.1.3. Provision for padlocking in on-off switch position by three locks.

2.1.4. Mechanically interlocked door to prevent opening when handle in ON position.

2.1.5. Fuses: size as indicated, class J, current limiting, in accordance with Section 26 28 14.00 – FUSES LOW VOLTAGE.

2.1.6. Fuse-holders: suitable without adaptors, for type and size of fuse indicated.

2.1.7. Quick-make, quick-break action.

2.1.8. ON-OFF switch position indication on switch enclosure cover.

2.2. EQUIPMENT IDENTIFICATION

- 2.2.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
- 2.2.2. Indicate name of load controlled on nameplate.
- 2.2.3. Provide a Lamacoid nameplate that indicates the replacement fuse size as well as the maximum allowable fuse size for that disconnect based upon the sizing of the feeder.

2.3. MANUFACTURERS

- 2.3.1. The following are acceptable manufacturers:
 - .1 Schneider Electric.
 - .2 Eaton Cutler-Hammer.
 - .3 Siemens.
 - .4 ABB.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install disconnect switches complete with fuses if applicable.

END OF SECTION

26 29 00.00 Motor Starters to 600 V

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 53.00 – IDENTIFICATION.

1.1.4. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.

1.2. REFERENCES

1.2.1. IEC 947-4-1, Part 4: Contactors and motor-starters, latest edition. Select IEC or NEMA rated devices depending on the project requirements

1.2.2. CSA C22.2 No. 60947-4-1 – Low-voltage switchgear and control gear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters, latest edition.

1.2.3. Attachment A – Loose Starter Schedule

1.2.4. Attachment B – MCC Schedule.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

.1 Indicate:

.1 Mounting method and dimensions.

.2 Starter size and type.

.3 Layout of identified internal and front panel components.

.4 Enclosure types.

.5 Wiring diagram for each type of starter.

.6 Interconnection diagrams.

1.3.2. Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

1.4. OPERATION AND MAINTENANCE DATA

1.4.1. Provide operation and maintenance data for motor starters for incorporation into manual.

1.4.2. Include operation and maintenance data for each type and style of starter.

1.5. MAINTENANCE MATERIALS

1.5.1. Provide listed spare parts for each different size and type of starter:

.1 Stationary contacts.

.2 Movable contacts.

- .3 Auxiliary contacts.
- .4 Control transformer.
- .5 Operating coil.
- .6 Fuses.
- .7 Indicating lamp bulbs used.

1.6. WARRANTY

- 1.6.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. MATERIALS

- 2.1.1. Starters: to IEC 947-4 with AC4 utilization category.

2.2. EQUIPMENT

- 2.2.1. All starters (with the exception of manual motor starters) are to be combination starters with fusible disconnect switches.
- .1 All fusible disconnects are:
 - .1 To be of the quick make and quick break type.
 - .2 To have an operating handle on the outside of the enclosure.
 - .3 To have fuse clips suitable for High Rupturing Capacity (HRC) Class J fuses.
 - .2 The operating handle of the fusible disconnect switch must be:
 - .1 Capable of being locked in the "OFF" position.
 - .2 Have provisions of accepting 3 pad locks.
 - .3 Have provision for preventing switching to "ON" position while enclosure door is open.
- 2.2.2. All starters, with the exception of manual motor starters, are to be provided with a single phase, dry type control circuit transformer with:
- .1 A fused primary.
 - .2 Primary voltage as indicated.
 - .3 120 V secondary.
 - .4 Secondary fusing.
- 2.2.3. Size the control transformer for control circuit load plus 20 % spare capacity, minimum capacity 150 VA.
- 2.2.4. All starters shall be equipped with indicating lamps that are long life cluster LED style.
- 2.2.5. All starters shall be provided with 3 phase bimetallic overload relays which are adjustable and are ambient temperature compensated. Manual resets for the overload relays are to be mounted on the enclosure door such that they can be reset from outside of the enclosure and have externally visible trip indication.
- 2.2.6. All starters shall have identification for each wire and terminal for external connection, within starter, with permanent number marking identical to diagram.

2.3. MANUAL MOTOR STARTERS

2.3.1. Single or three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

- .1 Switching mechanism, quick make and break.
- .2 One overload heater per phase, manual reset, trip indicating handle.

2.3.2. Accessories:

- .1 Toggle switch: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating light: oil tight type and colour as indicated on the Starter Schedule.
- .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.4. FULL VOLTAGE MAGNETIC STARTERS

2.4.1. Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

- .1 Contactor solenoid operated rapid action type.
- .2 Motor overload bimetallic protective relay.
- .3 Wiring and schematic diagram inside starter enclosure in a visible location.

2.4.2. Accessories:

- .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating lights: oil tight type and color as indicated on the Starter Schedule.
- .3 2-N/C and 2 N/O spare auxiliary contacts unless otherwise indicated on the Starter Schedule.

2.5. FULL VOLTAGE REVERSING MAGNETIC STARTERS

2.5.1. Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

- .1 Two - 3 pole magnetic contactors mounted on a common base.
- .2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.
- .3 Motor overload bimetallic protective relay.
- .4 Wiring and schematic diagram inside starter enclosure in a visible location.

2.5.2. Accessories

- .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
- .2 Indicating lights: heavy duty oil tight type and color as indicated on the Starter Schedule.
- .3 Auxiliary control devices as indicated on the Starter Schedule.

2.6. MULTI-SPEED STARTERS

2.6.1. (2) Speed starters of size type, rating and enclosure type as indicated. Starter suitable for variable torque type motor, unless otherwise indicated, 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 re-connectable winding for consequent pole type motors.
- .3 Three overload relays.
- 2.6.2. Accessories:
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight, type and color as indicated on the Starter Schedule.
 - .3 Auxiliary control devices as indicated on the Starter Schedule.
 - .4 Low speed compelling relay and automatic sequence accelerating, decelerating relays for each speed.
- 2.7. MAGNETIC STARTER, REDUCED VOLTAGE, AUTO-TRANSFORMER
 - 2.7.1. Auto-transformer starter closed circuit transition type, of size, type, rating and enclosure type as indicated and with following components:
 - .1 Three 3-pole contactors.
 - .2 Auto-transformer with 50%, 65% and 80% taps.
 - .3 One adjustable pneumatic timing relay.
 - .4 One 3-pole manual reset overload device.
 - .5 Thermal overload protection of auto- transformers.
 - 2.7.2. Accessories:
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight type and color as indicated on the Starter Schedule.
 - .3 Auxiliary control devices as indicated on the Starter Schedule.
- 2.8. MAGNETIC STARTER REDUCED VOLTAGE STAR-DELTA
 - 2.8.1. Reduced voltage star-delta open transition starter, of size, type, rating and enclosure type as indicated, with components 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 the star contactor.
 - .4 One timing relay.
 - .5 Three overload relays.
 - 2.8.2. Reduced voltage star-delta closed transition starter, of size, type, rating and enclosure type as indicated, with components 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 the star contactor.
 - .6 One timing relay.

- .7 Three overload relays.
- 2.8.3. Accessories:
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight, type and color as indicated on the Starter Schedule.
 - .3 Auxiliary control devices as indicated on the Starter Schedule.
- 2.9. MAGNETIC STARTER REDUCED VOLTAGE PART WINDING
 - 2.9.1. Two-step reduced voltage, part winding starter of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two 3-pole contactors.
 - .2 Adjustable pneumatic timer.
 - .3 Six Choose an item.reset overload relays.
 - 2.9.2. Three step reduced voltage part winding starter of size, type, rating and enclosure type as indicated, with the following components:
 - .1 Three 3-pole contactors.
 - .2 One set starting resistors.
 - .3 Six overload relays.
 - 2.9.3. Accessories:
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight type and color as indicated on the Starter Schedule.
 - .3 Auxiliary control devices as indicated on the Starter Schedule.
- 2.10. THREE PHASE MANUAL REVERSING STARTER
 - 2.10.1. Three phase manual reversing starter of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two 3-pole manual motor starters, quick make and break.
 - .2 Six overload relays and manual reset.
 - .3 Mechanical interlock to prevent both switches from closing at same time.
 - 2.10.2. Accessories
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight type and colour as indicated on the Starter Schedule.
- 2.11. THREE PHASE MANUAL TWO SPEED SEPARATE WINDING STARTERS
 - 2.11.1. Three phase manual two speed separate winding starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Two 3-pole manual motor starters, quick make and break.
 - .2 Six overload relays and manual reset.

- .3 Mechanical interlock to prevent both switches from closing at same time.
- 2.11.2. Accessories:
 - .1 Pushbuttons or Selector switches: heavy duty oil tight labeled as indicated on the Starter Schedule.
 - .2 Indicating lights: heavy duty oil tight type and colour as indicated on the Starter Schedule.
- 2.12. ENCLOSURE
 - 2.12.1. Starter to come in a CSA Type 3R enclosure, size as indicated.
 - 2.12.2. Equipment to be painted: baked grey enamel.
- 2.13. MANUFACTURERS
 - 2.13.1. The following are acceptable manufacturers:
 - .1 Schneider Electric.
 - .2 Eaton Cutler-Hammer.
 - .3 Siemens.
 - .4 ABB.
- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Install starters, connect power to starter and control and provide wiring from starter to motor through a manual disconnecting device if required by code.
 - 3.1.2. Coordinate with Mechanical Division Contractor to ensure correct fuses and overload devices elements installed.
 - 3.2. FIELD QUALITY CONTROL
 - 3.2.1. Perform tests in accordance with Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE and manufacturer's instructions. Contractor to oversee all testing and correct any deficiencies noted.
 - 3.2.2. Operate switches, contactors to verify correct functioning.
 - 3.2.3. Perform starting and stopping sequences of contactors and relays.
 - 3.2.4. Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

26 51 13.00 Lighting Equipment

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- 1.1.2. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.3. Section 26 05 04.00 – SUBMITTALS – SHOP DRAWINGS.
- 1.1.4. Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.
- 1.1.5. Section 26 06 05.16 – LUMINAIRE SCHEDULE.

1.2. REFERENCES

- 1.2.1. CSA C22.2 No. 74 – Equipment for Use with Electric Discharge Lamps, latest edition.
- 1.2.2. The Consortium of Energy Efficiency (CEE) guidelines, latest edition.
- 1.2.3. IESNA LM-79 – Approved Method: Electric and Photometric Measurements of Solid-State Lighting Products, latest edition.
- 1.2.4. IESNA LM-80 – Approved Method: Measuring Lumen Maintenance of LED Light Sources, latest edition.
- 1.2.5. The Certified Ballast Manufacturers Association (CBM) standards, latest edition.
- 1.2.6. NEMA 410 – Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts, latest edition.
- 1.2.7. CSA C22.2 No. 141 – Emergency Lighting Equipment, latest edition.

1.3. SUBSTITUTION

- 1.3.1. The lighting equipment for this project and specified herein has been carefully selected for its ability to meet the project's luminous environment requirements. Manual and computer calculations have been performed to ensure that the lighting equipment that has been specified complies with established criteria. The Engineer's Representative reserves the right not to accept any alternates or substitutions in accordance with the requirements of the Luminaire Schedule. If alternates or substitutions are entertained, then it is the responsibility of the Contractor/Supplier to provide: a comparison table showing the specified and the proposed luminaire performance information, IES files for the proposed luminaires, the information required herein, and detailed layouts and lighting calculations demonstrating that the performance of the alternate luminaire meets or exceeds the original lighting design while not consuming any additional energy. An extra review fee, per luminaire submitted, will be charged to the Contractor (with no additional costs to the Project Owner). Reviewed alternates may be rejected, regardless of the payment fee received, when alternates do not meet the project requirements. Invoices must be paid prior to Consultant's review starting or changes in the design documents to incorporate the proposed alternates after their review. The Contractor/Supplier is responsible to ensure the light levels provided in the alternate submittal package will achieve the design light levels. Where the light levels are not achieved, the Contractor is responsible to replace the luminaire with a luminaire that will meet the required levels with no increase in energy use at no cost to the Owner. Rather than replacing the luminaires, the Engineer's Representative may accept the installation of additional luminaires by the Contractor at no cost to the Owner in order to achieve the required light levels.

- 1.3.2. Accompanying the request for a luminaire or lamp substitution, the contractor shall submit a complete lighting calculation report with photometric modeling of the space showing light levels including average, maximum, minimum and max to min values.
- 1.4. SHOP DRAWING AND PRODUCT DATA
- 1.4.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.4.2. Submit a Shop Drawing for each luminaire specified, including lamp.
- 1.4.3. Luminaire submittals are to consist of a physical description, manufacturer's specification sheets, dimensioned drawings, and complete photometric data from an independent test laboratory in the form of IES computer files of the equipment being submitted and hard copy of the photometric report. Coordinate ceiling types to ensure proper supports and luminaire framing.
- 1.4.4. Lamp submittals are to consist of manufacturer's technical data with respective luminaire shop drawing. Submittal to include operating wattage, rated life, colour temperature, base type, lamp shape, CRI, and voltage.
- 1.4.5. LED submittals are to consist of manufacturer's technical data for diodes and drivers with respective luminaire shop drawing. Submittal to include operating wattage, voltage, maximum distance from drivers, wiring diagrams and lumen output at time of delivery.
- 1.4.6. Ballast submittals are to consist of manufacturer's technical data with respective luminaire shop drawing. Submittal to include operating wattage, input voltage, ballast efficiency, maximum distance for remote ballasts, power factor, and operating temperature.
- 1.4.7. Where samples are indicated on the luminaire schedule, they are to be provided with shop drawings at time of shop drawing submittals unless noted otherwise.
- 1.4.8. Where luminaires consist of multiple field assembled components, include manufacturer supplied installation manual detailing the assembly procedure.
- 1.5. OPERATION AND MAINTENANCE DATA
- 1.5.1. Provide operation and maintenance data for lighting equipment in accordance with Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS for incorporation into the manual.
- 1.5.2. Operation and maintenance instructions shall include documentation related to warranty claim process.
- 1.6. FIXED PER UNIT COST LUMINAIRES
- 1.6.1. Listed in the luminaire schedule are a fixed per unit cost for certain luminaire types. Electrical Contractor is responsible for completing a take-off of the drawings to determine quantity of each luminaire type and use the listed fixed unit price to calculate the total cost per luminaire type. The total cost for all luminaires shall be carried in the bid for the electrical contract. Provide a breakdown of the total cost, per luminaire type, that is carried under the electrical contract. All luminaires are to be included in the electrical contract including all luminaires identified with fixed unit costs. The Electrical Contractor is to include fixed per unit cost luminaires in Light Fixtures – Materials in the standard progress draw breakdown defined in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.6.2. The fixed per unit cost excludes applicable taxes and includes lamps and distributor markups. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all fixed per unit cost luminaires. Show the applicable taxes as a separate line item.

1.7. CASH ALLOWANCE LUMINAIRES

- 1.7.1. Listed in the luminaire schedule are 'cash allowance' fixtures for certain luminaire types. A complete take-off of the drawings has been done to determine the quantity of each 'cash allowance' luminaire type and the total cost has been carried in the Div-0/1 cash allowance value. The total cost for all 'cash allowance' luminaires are NOT to be carried in the bid for the electrical contract.
- 1.7.2. After tender award to the successful Electrical Contractor, the Consultant shall provide the Electrical Contractor the exact manufacturer/model number(s) of all 'cash allowance' luminaires and the Electrical Contractor shall be responsible for purchasing the fixtures through the monies from the cash allowance.
- 1.7.3. Provide a breakdown of the total cost, per luminaire type, that is carried under the base electrical contract. All luminaires are to be included in the base electrical contract excluding all luminaires identified as 'cash allowance' luminaires. However the Electrical Contractor is to include 'cash allowance' luminaires in Light Fixtures – Materials in the standard progress draw breakdown defined in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS once the Consultant provides the Electrical Contractor with the exact manufacturer/model number(s).
- 1.7.4. The cash allowance value carried excludes applicable taxes and includes lamps and distributor markups. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all 'cash allowance' luminaires. Show the applicable taxes as a separate line item.

1.8. WARRANTY

- 1.8.1. The manufacturer shall provide a warranty against defects in material and workmanship, starting at Substantial Performance of the Work. Parts warranty shall be 5 years and labour warranty shall be 1 year.
- 1.8.2. LED's, Drivers, Lamps and ballasts showing signs of premature failure shall be replaced at no cost to the owner.
- 1.8.3. LED Drivers must have a 5 year warranty.

2. Product

2.1. GENERAL

- 2.1.1. Only utilize Products that are certified for use in Canada in accordance with the requirements of Section 2 of the Electrical Code and that have been tested by a Certification Body accredited by the Standards Council of Canada and acceptable to the Electrical Authority Having Jurisdiction for the approval of electrical equipment. Furthermore, ensure that Products utilized have been approved to a recognized Canadian Standard.

2.2. LAMPS AND LEDS

- 2.2.1. All Lamps are to meet the standards of the Consortium of Energy Efficiency (CEE) guidelines.
- 2.2.2. Refer to luminaire schedule for project specific details, and lamps required.
- 2.2.3. Lamps are to be in accordance with the lamp specifications detailed in the Luminaire Schedule and as noted below. Luminaire schedule shall take precedence where differences occur.

- 2.2.4. All lamps are to be new and are to be from the same manufacturing batch to avoid colour differences. Replace all lamps that exhibit colour shift, or exhibit premature lumen intensity decline, at no cost to the owner.
- 2.2.5. Light Emitting Diodes (LED)
- .1 LEDs shall meet the standards of IESNA LM-79 and LM-80.
 - .2 All LED drivers shall be tested and comply with the maximum in-rush current limits as stated in NEMA 410.
 - .3 LED's shall be manufactured by Cree, Osram, Nichia, Toshiba, Lumileds, Bridgelux, or Samsung. Colour temperature shall be as indicated on the luminaire schedule. Lamps are to be binned with no visible colour variance (+/- 100K from specified colour temperature). Rated life for 1 watt white LED shall be 50,000 hours. Lumen output to be maximum based on latest technology at time of delivery.
 - .4 All LED luminaires that present signs of failure on site, within the warranty period, must be replaced at no cost to the owner. If temporary luminaires are required to replace any failed LED luminaires, during the waiting time for parts (i.e. drivers, boards, heat sinks, etc.), the labour cost including installation, temporary luminaire supply, temporary luminaire removal and reinstallation of the LED luminaire must be provided at no cost of the owner. Additional electrical costs, associated with higher Wattage temporary luminaires, must be reimbursed with interest to the owner by the manufacturer.
 - .5 In case of failure of an LED luminaire, complete or part thereof, an independent third party testing Laboratory (approved by Smith + Andersen) shall be commissioned by the manufacturer or vendor to perform tests on samples taken from the failed luminaires installed on corresponding site. All reporting including the test results must be submitted to Smith + Andersen for evaluation and final approval.
 - .6 Any additional time involved by Smith + Andersen will be billed at our hourly rates to the manufacturer or vendor.
- 2.3. DRIVERS
- 2.3.1. All drivers are to be tested and comply with maximum in-rush current limits within NEMA 410 standards. This is to be clearly indicated on shop drawing submittal.
- 2.3.2. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
- 2.3.3. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
- 2.3.4. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
- 2.3.5. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
- 2.3.6. Total Harmonic Distortion less than 20 % percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
- 2.3.7. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
- .1 Adjustment of forward LED voltage, supporting 3 V through 55 V.

- .2 Adjustment of LED current from 200 mA to 1.05 A at the 100 percent control input point in increments of 1 mA.
- .3 Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.
- 2.3.8. Driver must be able to operate for a (+/- 10%) supply voltage of 120 V through 277 VAC at 60 Hz.
- 2.3.9. Driver must be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
- 2.3.10. Driver shall include ability to provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and shall consume 0.5 watts or less in this standby. Control deadband between 0.5 V and 0.65 V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.
- 2.3.11. Over the entire range of available drive currents, driver shall provide step-free, continuous dimming to black from 100 percent to 0.1 percent and 0 % relative light output, or 100 – 1 % light output and step to 0 % where indicated. Driver shall respond similarly when raising from 0 % to 100 %
 - .1 Driver must be capable of 20 bit dimming resolution for white light LED drivers or 15 bit resolution for RGBW LED drivers.
- 2.3.12. Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels
- 2.3.13. Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.
- 2.3.14. Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have:
 - .1 LED dimming driver shall provide continuous step-free, flicker free dimming similar to incandescent source.
 - .2 Base specification: Flicker index shall less than 5% at all frequencies below 1000 Hz.
 - .3 Preferred specification: Flicker index shall be equal to incandescent, less than 1% at all frequencies below 1000 Hz.
- 2.3.15. Control Input
 - .1 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
 - .1 Must meet IEC 60929 Annex E for General White Lighting LED drivers
 - .2 Connect to devices compatible with 0 to 10 V Analog Control Protocol, Class 2, capable of sinking 0.6 mA per driver at a low end of 0.3 V. Limit the number of drivers on each 0-10 V control output based on voltage drop and control capacity.
- 2.3.16. Must meet ESTA E1.3 for RGBW LED drivers
- 2.3.17. Provide drivers manufactured by Cree, Osram, Nichia, Toshiba, Lumileds, Bridgelux, Samsung, or Edoleds.

2.4. BALLASTS

- 2.4.1. All Ballasts shall comply with CSA C22.2 No. 74 and are to meet or exceed the standards of the Certified Ballast Manufacturers Association (CBM).
- 2.4.2. All ballasts shall be tested and comply with maximum in-rush current limits as stated in NEMA 410.
- 2.4.3. Not all ballasts could be used, refer to luminaire schedule for project specific details.
- 2.4.4. All ballasts shall be manufactured by Osram/Sylvania, Philips, Advance, GE, Lutron or Magnetek unless indicated otherwise. Ballasts shall operate at voltage and control lamps as noted in the Luminaire Schedule.
- 2.4.5. Ballasts shall contain no PCB's and audible rating will be class A or better.
- 2.4.6. Racks are to be provided for remote ballasts.
- 2.4.7. Ballasts with unacceptable noise levels are to be replaced at no cost to the owner.

2.5. LUMINAIRES

- 2.5.1. All luminaires are to be complete with mounting brackets, transformers, supports, trims, louvers, lenses and other accessories as required to make luminaire operational and allow it to be installed in the respective location.
- 2.5.2. Luminaires shall be suitable for the environment where installed, include seals and gaskets, and corrosion resistant baked-on finish as required and as specified.
- 2.5.3. Louvers, lenses and diffusers must be of suitable thickness to prevent sagging.
- 2.5.4. Where drawings show luminaires mounted end-to-end, luminaires shall be suitable for continuous, seamless and tandem mounting.
- 2.5.5. All poles are to come complete with internal vibration dampeners to accommodate wind conditions to avoid damage due to wind-induced vibrations.
- 2.5.6. All concrete bases for poles and bollards shall be designed to accommodate the height, weight, etc. of the pole/bollard and its accessories for the soil conditions for which it is installed. Engineered shop drawings shall be provided that is signed by a structural engineer registered in the local jurisdiction.
- 2.5.7. Where cameras are shown to be installed on poles, the poles shall be stiffened to reduce vibration and sway, and shall be rated for video recording cameras.
- 2.5.8. The supply and installation of fixed per unit cost and 'cash allowance' luminaires shall comply with all standards set forth in Electrical Specifications. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all fixed per unit cost and 'cash allowance' luminaires.
- 2.5.9. Provide exit signs that comply with building code requirements, including CSA C22.2 No. 141.
- 2.5.10. The following is a list of generic type designation for luminaires. The project specific luminaire schedule is to be referenced for the specific types and designations and the respective specifications.
 - .1 Designations beginning with the letter 'L' denote LED type.
 - .2 Designations beginning with the letter 'X' denote exit sign.

3. Execution

3.1. INSTALLATION

- 3.1.1. It is the responsibility of the contractor to obtain the information related to the luminaire and luminaire trim finishes/colours from the Interior Designer or Architects prior to the fabrication of luminaires. The Contractor shall provide adequate time for the design team to review and comment on luminaire and luminaire trim finishes.
- 3.1.2. The contractor will provide, receive, unload, uncrate, store, protect and install lamps, luminaires, and other related lighting equipment as specified herein. Lamps for all equipment will be provided and installed by the contractor according to equipment manufacturer's instructions.
- 3.1.3. The Electrical Contractor shall be responsible for the supply and installation of all concrete bases for poles and bollards. Unless otherwise shown on the drawings, concrete bases to be ArtForm style or Approved Equal and shall extend a minimum 900 mm above grade in parking lots and a minimum 150 mm above grade in pedestrian walkways.
- 3.1.4. Poles and bollards are to be installed on independent concrete bases unless indicated otherwise on the drawings or schedules. Coordinate brackets for cameras and supports for banners with pole manufacturer.
- 3.1.5. Install remote ballasts in racks and wire luminaires to ballasts in conduit. Provide wiring as per manufacturer's recommendations.
- 3.1.6. Locate luminaires in accordance with the Architect's Drawings. Coordinate exact locations on site. Refer to Architect's drawings for dimensions of coves and valences.
- 3.1.7. Install in accordance with Manufacturer's Instructions, Local Codes, Electrical Division Drawings and Specifications.
- 3.1.8. All suspended luminaires shall have cables and support stems vertically aligned.
- 3.1.9. Suspend luminaires in mechanical rooms after all the mechanical equipment and ductwork are installed. Luminaires are not to be suspended from mechanical pipes, ductwork or other building services.
- 3.1.10. All luminaires shall be installed underneath other services located within ceiling space. Contractor is responsible for interference drawings to ensure all services in ceiling are coordinated.
- 3.1.11. Any dimensions provided in the drawings or schedules are intended as general guidelines. For exact dimensioning refer to the Architectural drawings. The detailed information shall be cross referenced with the electrical specifications and the Luminaire Schedule applying the most stringent requirement.
- 3.1.12. It is the responsibility of the Electrical Contractor to coordinate luminaire trims and mounting system with ceiling finishes. Luminaires delivered on site with the wrong ceiling mounting system shall be replaced without additional costs for the owner. Restocking fees will not be accepted.
- 3.1.13. For suspended ceiling installations support luminaires from structural slab in accordance with local inspection requirements.
- 3.1.14. Where luminaires are mounted in tandem, align luminaires mounted in continuous rows to form straight uninterrupted line.
- 3.1.15. Align luminaires mounted individually parallel or perpendicular to building grid lines.
- 3.1.16. Ensure light leakage does not occur from openings and trim rings. Contractor is responsible to repair the ceiling at no cost to the Owner if cut-out is too large.
- 3.1.17. Connect luminaires to lighting circuits.

- 3.1.18. Provide all wiring in conduit with junction boxes on a grid pattern to limit the run of flexible armoured cable drops from the ceiling mounted junction box to each luminaire to a maximum of 3 m in length unless approved otherwise in writing from the Engineer's Representative.
- 3.1.19. Modular wiring systems shall be employed only where indicated or with approval of the Engineer's Representative.
- 3.1.20. Luminaires are not to be used as temporary construction lighting. After being tested to ensure acceptable operation, luminaires will not be used until Substantial Performance of the Work unless permission is received from the owner, architect or Engineer's Representative.
- 3.1.21. Lamps are to be installed after luminaire is cleaned.
- 3.1.22. Clean all luminaires, inside and out at time of Substantial Performance of the Work. Replace all scratched or damaged luminaires, lenses, louvers and diffusers at no cost to the owner.
- 3.1.23. Installation of exit signs
 - .1 Rough-in and installation of exit signs shall be carefully coordinated on site such that after installation of all equipment/services, including equipment/services from other trades (i.e. sprinkler lines, plumbing pipes, way-finding signs, etc.), shall not interfere with the line-of-sight visibility of the exit sign(s) from approach of the intended egress pathway(s).
 - .2 If exit sign(s) have been installed and do not meet the satisfaction of the Engineer's Representative/Architect, the Contractor shall lower, raise or relocate the exit sign(s) such that proper and adequate visibility of the exit sign(s) is achieved at no additional cost to the Owner.

END OF SECTION

26 52 01.00 Unit Equipment for Emergency Lighting

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.

1.1.4. Section 26 05 34.00 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.

1.2. REFERENCES

1.2.1. CSA Standard C22.2 No.141 – Emergency Lighting Equipment, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.3.2. Submit Shop Drawings for equipment and accessories specified in this Section. Include photometric data for all luminaires not named as approved in this specification.

1.3.3. Data to indicate system components, mounting method, source of power and special attachments.

1.3.4. Manufacturer/Contractor to ensure runtime capacity of battery unit is sized accordingly to meet the runtimes specified within this section and/or drawings/schedules.

1.4. WARRANTY

1.4.1. For batteries, the warranty period shall be extended to 120 months from Substantial Performance of the Work, with a no-charge replacement during the first 5 years and a pro-rata charge on the second 5 years.

2. Products

2.1. EQUIPMENT

2.1.1. Supply voltage: 120 V, ac.

2.1.2. Output voltage: 24 V dc.

2.1.3. Operating time: 120 minutes, unless otherwise noted in schedules.

2.1.4. Battery: 10 year sealed, valve regulated, lead calcium.

2.1.5. Charger: 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. Recharges battery within 24 hours in accordance with CSA.

2.1.6. Solid state transfer circuit.

2.1.7. Low voltage disconnect: solid state, modular, operates at 80 % battery output voltage.

2.1.8. Signal lights: solid state, for 'AC Power ON' and 'High Charge'.

- 2.1.9. Lamp heads: integral on unit and remote as indicated, 345 horizontal and 180 vertical adjustment. Lamp type: LED MR16, wattage to be 6 W unless noted otherwise on drawings or in the "Battery Unit Schedule."
- 2.1.10. Directional remote head lamps to have narrow beam spread distribution.
- 2.1.11. Recessed remote head lamps to have flood beam spread distribution.
- 2.1.12. Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- 2.1.13. Finish: Baked white enamel.
- 2.1.14. 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 Bracket.
 - .8 Cord and single twist-lock plug connection for ac.
 - .9 RFI suppressors.
- 2.2. WIRING OF REMOTE HEADS AND EXIT SIGNS
 - 2.2.1. Conduit: As per Section 26 05 34.00 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.
 - 2.2.2. Conductors: As per Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V, sized as per manufacturer's recommendation and compliant to the applicable electrical codes.
- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Install unit equipment and remote mounted fixtures. Interconnect all heads with central battery pack.
 - 3.1.2. Direct heads to optimize illumination of egress pathways to minimum building code requirements.
 - 3.1.3. Connect exit lights to unit equipment.
 - 3.1.4. Contractor is to include the supply and installation of one additional head or an additional 5% of the total number of heads shown on the drawings, whichever is greater in the bid price. The installation is to include all wiring and conduit required to install the heads. If the heads are not installed during construction then the spare heads are to be turned over to the Owner at the end of the project.
 - 3.2. TESTING AND COMMISSIONING
 - 3.2.1. Contractor shall commission and test the entire system and adjust as necessary.
 - 3.2.2. Trip breaker(s) feeding battery unit(s) to simulate power failure to building. Test the operation of each unit to document the duration of runtime. Testing shall be performed during non-daylight hours.

- 3.2.3. Inform Engineer's Representative 10 days in advance prior to testing being performed in order for Engineer's Representative to make arrangements to witness testing of emergency lighting system.
- 3.2.4. Provide Engineer's Representative with signed test report by Contractor that each unit successfully operated for the required duration of time.
- 3.2.5. Re-test voltage of battery units 24 hours after initial testing to verify rated nominal voltage of unit. If battery unit has not recharged properly, replace unit and re-test as stated above at no additional cost to Owner.

END OF SECTION

26 60 01.00 Elevator Services

1. General

1.1. WORK INCLUDED

- 1.1.1. Comply with Elevator Division specifications.
- 1.1.2. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.3. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCE

- 1.2.1. ASME A17.1/CSA-B44 – Safety Code for Elevators and Escalators, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4. DESCRIPTION OF SYSTEM

- 1.4.1. Provide elevator machine power supply, wiring, lighting, life safety and receptacle systems for machine room, pits and secondary levels, power, security, music, communication and life safety provisions for cab(s), and conduit and wiring to and for associated control and equipment.

1.5. WARRANTY

- 1.5.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. MATERIALS

- 2.1.1. Individual lockable fusible disconnect switches or panelboards, with rating, number of poles, and configuration as indicated for:
 - .1 Machine power.
 - .2 Lighting for machine room, and pits and secondary levels.
 - .3 Machine room and pit receptacles.
 - .4 Machine room exhaust fan and A/C unit.
 - .5 Group controller power.
 - .6 Power for cab exhaust fan and cab lighting.
 - .7 Intercom – two-way supervised voice communication system.
 - .8 Provide an intercom/two-way voice communication system for the elevators which will allow the following:
 - .9 Two-way voice communication between each elevator and the Central Alarm and Control Facility.
 - .10 Two-way voice communication between each elevator and off site monitoring centre.

- .11 Electrical Division will be responsible for providing and making operational the entire system except for providing the hoistway wiring between each elevator and its respective machine room and installing the two-way speaker in each cab which will be by Division 14.
- .12 Provide one EVAC speaker in each elevator cab connected to the fire alarm system. Coordinate installation with Division 14. Division 14 will provide wiring from terminal box in machine room to each elevator cab. All other work will be by Electrical Division.

3. Execution

3.1. INSTALLATION

- 3.1.1. Interface between work for Electrical Division and Elevator Contractor. For all systems, Electrical Contractor shall terminate all wiring at the terminals of elevator or escalator controller(s) in the respective machine rooms or pits.
- 3.1.2. Coordinate the locations of all equipment with Elevator Contractor prior to installation.
- 3.1.3. Install disconnect switches or panelboards in the machine rooms as indicated.
- 3.1.4. Install 27 mm conduit from nearest communication/telephone room to a 600 mm x 600 mm plywood backboard in each elevator machine room. Install 21 mm conduit system for telephones to each elevator controller from the backboard.
- 3.1.5. Install lights, switches and receptacles for machine room, pit and shaft as indicated.
- 3.1.6. Provide wiring in 21 mm conduit from each elevator controller to the fire alarm system as described below and as described in the fire alarm specification section to initiate elevator recall. All fire alarm wiring to be as per fire alarm specification section and approved for the installation.
 - .1 For conventional/hard wired fire alarm systems, provide wiring in 21 mm conduit from the auxiliary contact on the detectors located in the elevator shaft, in the elevator lobbies and in the elevator machine room to each of the elevator controllers, as further described in the fire alarm specification section.
 - .2 For addressable fire alarm systems, provide addressable output relays as described in the fire alarm specification section and provide wiring from each respective relay to the respective elevator controller.
- 3.1.7. Provide separate 53 mm conduits from each elevator shaft to the CACF or main elevator control panel location. Install control wiring within these conduits. Wiring to be supplied by Elevator Contractor.
- 3.1.8. If hydraulic elevators utilize battery-pack emergency power lowering feature, provide on the main disconnect switch, a CSA approved, positive action auxiliary interlock switch that prevents "down" operation, when opened, as required by and as approved by the governing body having jurisdiction. Provide wiring from auxiliary switch in 16 mm conduit to the respective elevator controller.
- 3.1.9. Provide wiring in conduit from each automatic transfer switch (ATS) in the building to all of the elevator controllers fed from the respective ATS to connect the pre-transfer, post-transfer and inhibit signals. Include for 2 spare wiring pairs in this run of conduit.
- 3.1.10. Provide two 103 mm conduits from each elevator machine/controller room to each of the elevator shafts when the elevator machine/controller room is not adjacent to the elevator shaft.
- 3.1.11. Electrical contractor to coordinate all sleeving requirements with Elevator Contractor.

END OF SECTION

26 60 20.00 Hand Dryers

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. SHOP DRAWINGS AND PRODUCT DATA

1.2.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. DESCRIPTION

2.1.1. The hand dryers shall be recess-mounted, polycarbonate fascia with Antibacterial coating, Sprayed Nickel finish.

2.1.2. Acceptable manufacturer and model number is Dyson Airblade V, 120V, 60 Hz, 1000W, with brushless type motor.

3. Execution

3.1. INSTALLATION

3.1.1. Supply, install and provide power connections to the hand dryers as indicated on the electrical plans. Co-ordinate mounting height with architectural plans.

3.1.2. Install hand dryers in accordance with manufacturer's recommendations.

END OF SECTION

28 05 00.00 Raceways for Security System

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. DESCRIPTION OF SYSTEM

1.2.1. Provide raceways and back boxes only for this security system. A complete security system shall be supplied and installed by others.

1.3. WARRANTY

1.3.1. Provide a warranty in accordance with the requirements of Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. SECURITY SYSTEM

2.1.1. The security system will be tendered by Division 28, security contractor. Coordinate with the security consultant, which division supplies and installs the wiring and cables, and which division installs and terminates the devices.

3. Execution

3.1. INSTALLATION

3.1.1. Install conduits and back boxes only.

END OF SECTION

28 31 02.00 Multiplex Fire Alarm System

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 05 34.00 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- 1.1.4. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.
- 1.1.5. Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.

1.2. REFERENCES

- 1.2.1. CAN/ULC-S524, Installation of Fire Alarm Systems, latest edition.
- 1.2.2. CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems, latest edition.
- 1.2.3. CAN/ULC-S537, Verification of Fire Alarm Systems, latest edition.
- 1.2.4. CAN/ULC-S1001, Integrated Systems Testing of Fire Protection and Life Safety Systems, latest edition.
- 1.2.5. CAN/ULC-S553, Standard For Installation of Smoke Alarms, latest edition.
- 1.2.6. CSA C22.2 No. 124, Mineral-Insulated Cable, latest edition.
- 1.2.7. CAN/ULC-S559, Standard for Equipment for Fire Signal Receiving Centres and Systems, latest edition.
- 1.2.8. CAN/ULC-S561, Standard for Installation and Services for Fire Signal Receiving Centres and Systems, latest edition.

1.3. SYSTEM DESCRIPTION

- 1.3.1. Existing fire alarm systems is a Simplex 4100U.
- 1.3.2. All equipment and components shall be new, and the manufacturer's current model.
- 1.3.3. Spare modules will be provided for future tenant tie ins. Panels will be tied into emergency standby generators, fire pumps, security panels, and auxiliary and ancillary devices.
- 1.3.4. Elevator shafts will have a weather proof heat detector located in the pit along with a smoke detector located at the top of the shaft.
- 1.3.5. Emergency power feed from generator(s) shall have two supervisory zones each, monitoring Generator Running and Generator General Trouble.
- 1.3.6. Emergency power feed from inverter(s) shall have three supervisory zones each, monitoring Inverter Running, Inverter on Bypass and Inverter General Trouble.
- 1.3.7. Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.
- 1.3.8. System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general and two-stage alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to monitoring agency.
- 1.3.9. Zoned, non-coded single stage or two stage, as indicated.

- 1.3.10. Modular in design to allow for future expansion.
- 1.3.11. Operation of system shall not require personnel with special computer skills.
- 1.3.12. System to include:
 - .1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling.
 - .2 Data Gathering Panels/Transponders with stand-alone capabilities.
 - .3 Power supplies.
 - .4 Initiating/input circuits.
 - .5 Indication/output circuits.
 - .6 Auxiliary circuits.
 - .7 Wiring.
 - .8 Manual and automatic initiating devices.
 - .9 Audible and visual signalling devices.
 - .10 End-of-line resistors.
 - .11 Local and remote annunciators.
 - .12 Printer and event log memory chip.
 - .13 Historic event recorder.
 - .14 Isolation modules.
 - .15 Central alarm monitoring.
 - .16 Programmed features.
- 1.4. REQUIREMENTS OF REGULATORY AGENCIES
- 1.4.1. System components shall be listed by ULC/CSA and comply with applicable provisions of the building code, and meet requirements of local authority having jurisdiction.
- 1.5. SHOP DRAWINGS AND PRODUCT DATA
- 1.5.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.5.2. Include:
 - .1 Detail assembly and internal wiring diagrams for control units and auxiliary cabinets.
 - .2 Overall system riser wiring diagram identifying control equipment, initiating zones, signaling circuits; and identifying terminations, terminal numbers, conductors and raceways.
 - .3 Details for devices.
 - .4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
 - .5 Step-by-step operating sequence, cross referenced to logic flow diagram.
 - .6 Submit battery sizing calculations and battery selection.

1.6. OPERATION AND MAINTENANCE DATA

1.6.1. Provide operation and maintenance data for fire alarm system for incorporation into the O&M manual.

1.6.2. Include:

- .1 Instructions for complete fire alarm system to permit effective operation and maintenance.
- .2 Technical data - illustrated parts lists with parts catalogue numbers.
- .3 Copy of approved Shop Drawings with corrections completed and marks removed except review stamps.
- .4 List of recommended spare parts for system.
- .5 Detailed sequence of operation or operational matrix.
- .6 Full fire alarm verification inspection report.
- .7 USB stick, containing electronic version of fire alarm passive graphic both in PDF and CAD, as part of O&M manual.

1.7. MAINTENANCE MATERIALS

1.7.1. Include:

- .1 Spare glass rods for manual pull stations, if applicable.
- .2 Key for fire alarm panel, remote annunciator, and pull stations.
- .3 Specialty tool for resetting sprinkler supervisory, if applicable.
- .4 Spare fuses for control circuits.
- .5 Beam detector calibrated test filters (if applicable).

1.8. WARRANTY

1.8.1. Provide a one-year warranty, starting at Substantial Performance of the Work, including all materials, parts, and labour. Be responsible for correcting any deficiencies that are discovered during the one year warranty period, including any that are discovered by the Owner's first annual inspection and test to CAN/ULC-S536.

1.9. TRAINING

1.9.1. Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

2. Product

2.1. MATERIALS

2.1.1. Equipment and devices: ULC listed, labelled and supplied by single manufacturer.

2.1.2. Power supply: to CAN/ULC-S524.

2.1.3. Audible signal devices: to ULC-S525.

2.1.4. Visual signal devices: to CAN/ULC-S526.

2.1.5. Control unit: to CAN/ULC-S527.

2.1.6. Manual pull stations: to CAN/ULC-S528.

- 2.1.7. Thermal detectors: to CAN/ULC-S530.
- 2.1.8. Smoke detectors: to CAN/ULC-S529.
- 2.1.9. Smoke alarms: to CAN/ULC-S531.
- 2.1.10. Signal Transmitting Units and Monitoring: to CAN/ULC-S559 and CAN/ULC-S561.
- 2.2. SYSTEM OPERATION: SINGLE STAGE SIGNALS ONLY
 - 2.2.1. Actuation of any alarm initiating device to:
 - .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder.
 - .2 Indicate zone of alarm at central control unit and at the remote annunciator.
 - .3 Cause audible signalling devices to sound continuously throughout building and at central control unit.
 - .4 Transmit signal to fire department via central station.
 - .5 Except for air handling systems providing make-up air to public corridors serving suites in Group C major occupancy High Buildings, cause air conditioning and ventilation fans serving more than 1 storey or 1 suite in a storey to shut down.
 - .6 For high rise buildings, provide manual 'OFF' switches at the main fire alarm panel in the CACF to manually stop air moving fan units that serves more than 2 storeys.
 - .7 Cause supply and/or exhaust fans to function automatically to provide required control of smoke movement per the mechanical smoke control matrix.
 - .8 Cause fire doors and smoke control doors, if normally held open, to close automatically.
 - .9 Cause the release of all mag-lock devices on doors that are secured closed.
 - 2.2.2. Emergency elevator recall:
 - .1 Actuation of any alarm initiating devices in elevator lobbies, elevator machine room, elevator pit, or top of hoistway to cause elevators to return to primary recall floor, or to alternate recall floor, as required. Elevator recall shall not be activated upon alarms from manual pull stations or on general fire alarm condition.
 - 2.2.3. Acknowledging alarm: indicated at central control unit.
 - 2.2.4. Actuation of supervisory devices to:
 - .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
 - .2 Indicate respective supervisory zone at central control unit and at remote annunciator.
 - .3 Cause audible signal at central control unit to sound.
 - .4 Activate common supervisory sequence.
 - 2.2.5. Resetting of alarm or supervisory device shall not return system indications/functions back to normal until control unit has been reset.
 - 2.2.6. Trouble on system to:
 - .1 Indicate circuit in trouble at central control unit.
 - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.
 - 2.2.7. Trouble on system: suppressed during course of alarm.
 - 2.2.8. Trouble condition on any circuit in system not to initiate alarm conditions.

2.3. CONTROL PANEL

2.3.1. Central control unit (CCU):

- .1 Suitable for Data Communication Link style C (DCL-C) unless otherwise noted on the drawings: to CAN/ULC-S524.
- .2 Features specified are minimum requirements for microprocessor-based system with digital data control and digital multiplexing techniques for data transmission.
- .3 Minimum capacity of 1000 addressable monitoring and 500 addressable control/signal points. Points may be divided between 2 communication channels in distributed system, each channel operating independently of other. Faults on one communication channel not to affect operation of other channel.
- .4 System to provide for priority reporting levels, with fire alarm points assigned highest priority, supervisory and monitoring lower priority, and third priority for troubles. Possible to assign control priorities to control points in system to guarantee operation or allow emergency override as required.
- .5 Integral power supply, battery charger and standby batteries.
- .6 Basic life safety software: retained in non-volatile Erasable Programmable Read-Only-Memory (EPROM). Extra memory chips: easily field-installed. Random-Access-Memory (RAM) chips in panel to facilitate password-protected field editing of simple software functions (e.g. zone labels, priorities) and changing of system operation software.
- .7 Circuitry to continuously monitor communications and data processing cycles of microprocessor. Upon failure, audible and visual trouble indication to activate.
- .8 Communication between CCU and remote DGP's/TPR's to be supervised, DCLA. Should communications fail between CCU and remote units, audible and visual trouble to be indicated at CCU. Data communication to be binary DC, baseband, time-division multiplex, half-duplex. Each data channel: capable of communicating up to distance of 3,000 m.
 - .1 Communication between nodes in networked system to be supervised, DCLA. Should communications fail between any 2 nodes, other nodes on loop to continue to communicate with each other and programmed functions on communicating nodes to continue operating.
- .9 Support up to 4 RS-232-C I/O ports. CCU output: parallel ASCII with adjustable baud rates to allow interface of any commercially available printer, terminal or PC.
- .10 Equipped with software routines to provide Event-Initiated-Programs (EIP); change in status of one or more monitor points, may be programmed to operate any or all of system's control points.
- .11 Software and hardware to maintain time of day, day of week, day of month, month and year.
- .12 On-board, 20-column, DC strip printer, thermal head with automatic paper take-up, and silent operation; operational while system is operating on standby power. Expanded font available for selected printing conditions.
- .13 Printer to record activities on system controlled by EIA RS-232-C link from within CCU.
- .14 Software to operate variable sensitivity addressable smoke detectors and annunciate their status and sensitivity settings at control panel.

2.4. DATA GATHERING PANELS (DGP'S) /TRANSPONDERS

- ### 2.4.1. Fire control modules: distributed throughout building complex in separately enclosed units (DGP'S) and interconnected to central control unit utilizing multiplex data transmission techniques.

- 2.4.2. Fire alarm integrated DGP's: microprocessor based, provide interface between standard alarm input/output devices and central control unit.
- 2.4.3. Each DGP: circuitry with ability to detect failure in communication with CCU resulting from faults in communication wiring. In event of loss of communication with CCU, DGP capable of operating in stand-alone mode. In this mode, DGP capable of reacting to connected input devices, and apply stand-alone programming to determine state of connected outputs. Stand-alone programming instructions: independent of, but capable of executing same type of algorithms as that of CCU.
- 2.4.4. Each DGP: self-contained unit, with integral power supply, battery charger and standby batteries. Short circuit, over voltage, and brown-out monitoring to protect powered components by automatically switching to standby batteries whenever trouble condition exists in power supply.
- 2.4.5. Addressable DGP's:
- .1 DGP's are to be of the addressable type which provide two-way data communication with up to 128 addressable devices/interface modules, utilizing digital poll/response protocol communication format. Each addressable device: uniquely identified by own address, set at time of installation.
 - .2 Addressable DGP's must have stand-alone operating capability.
 - .3 Interface modules: facilitate connection of non-addressable devices (e.g. flow switch) to addressable DGP; provided in different types for connection to monitoring devices (e.g. flow/tamper switch), signalling devices (e.g. bells, horns), and control functions (e.g. fan shutdown, door release); communicate with addressable DGP over minimum number of wires (specified by manufacturer).
 - .4 Possible to connect all 3 types of addressable interface modules (monitoring, signal and control) to same addressable communication loop.
 - .5 Possible to connect variable-sensitivity addressable smoke detectors together with other addressable devices to same addressable communication loop.
- 2.5. POWER SUPPLIES
- 2.5.1. 120V, 60 Hz as primary source of power for system. The circuit shall be labelled at the main power distribution panel as FIRE ALARM. The fire alarm disconnect must be locked, a locked electrical room or panel door does not constitute the lock for the disconnect.
- 2.5.2. Voltage regulated, current limited distributed system power.
- 2.5.3. Primary power failure or power loss (less than 102 V) will activate common trouble sequence.
- 2.5.4. Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
- 2.5.5. Abnormal operating conditions such as a fault in battery charging circuit, short or open in the battery leads, shall activate a common trouble sequence and standby power trouble indicator.
- 2.5.6. Standby batteries: 5 year NiCad sealed, maintenance free.
- 2.5.7. Continuous supervision of wiring for external initiating and alarm circuits are to be maintained for 24 hrs with capability of maintaining alarm activation for a minimum of 2 hrs, immediately following 24 hrs of supervision.
- 2.6. INITIATING/INPUT CIRCUITS
- 2.6.1. Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCL-C, as per CAN/ULC-S524, configuration to central control unit or DGP's/transponders.

- 2.6.2. Alarm receiving circuits (active and spare) are to be compatible with smoke detectors and open contact devices.
- 2.6.3. Actuation of alarm initiating device is to cause system to operate as specified in "System Operation".
- 2.6.4. Receiving circuits for supervisory devices are to be wired in DCL-A configuration to central control unit or DGP's/transponders.
- 2.6.5. Actuation of supervisory initiating device is to cause the system to operate as specified in "System Operation".
- 2.6.6. Sprinkler devices such as pressure switches and flow switches are to have the tamper switch wired after the switch and before the EOL, to create a trouble condition while still allowing the device to electrically initiate its respective zone.
- 2.6.7. Low room temperature devices are to be provided in sprinkler rooms whenever a dry sprinkler system is provided.
- 2.7. ALARM OUTPUT CIRCUITS
 - 2.7.1. Alarm output circuits are to be connected to signals, wired in class B configuration to the central control unit or DGP's/transponders.
 - 2.7.2. The signal circuits' operation is to be capable of sounding bells, horns as required. Each signal circuit: rated at 2 A, 24 VDC; fuse-protected from overloading/overcurrent.
 - 2.7.3. Manual alarm silence, automatic alarm silence and alarm silence inhibit is to be provided by system's common control.
 - 2.7.4. Separate circuits shall be provided for audible signal devices on each floor area.
 - 2.7.5. Audible signal devices within dwelling units or suites of residential occupancy shall be wired on separate signal circuits from those not within suites of residential occupancy or dwelling units.
 - 2.7.6. Provide 25% spare capacity in visual signal device circuits to allow for site adjustments of visual signal device candela ratings.
- 2.8. AUXILIARY CIRCUITS
 - 2.8.1. Auxiliary contacts for control functions.
 - 2.8.2. Actual status indication (positive feedback) from controlled device.
 - 2.8.3. Alarm or supervisory trouble on system to cause operation of programmed auxiliary output circuits.
 - 2.8.4. Five sets of separate contacts for elevator fire alarm recall, for each elevator or bank of elevators sharing a common shaft and common fire detectors:
 - .1 Elevator recall to primary floor, from elevator lobby smoke detectors on all floors except primary recall floor.
 - .2 Elevator top of shaft detection signal to elevator controller.
 - .3 Elevator pit detection signal to elevator controller.
 - .4 Elevator machine room detector signal to elevator controller.
 - .5 Elevator recall to alternate floor, from elevator lobby smoke detector(s) at primary recall floor.
 - 2.8.5. Upon resetting system, auxiliary contacts are to return to normal or to operate as pre-programmed.

- 2.8.6. Fans: stagger-started upon system reset; timing circuit to separate starting of each fan or set of fans connected to auxiliary contact on system. Timing circuit: controlled by CCU.
- 2.8.7. Auxiliary circuits: rated at 2 A, 24 V dc or 120 V ac, fuse-protected.
- 2.9. WIRING
- 2.9.1. All fire alarm system wiring must be new.
- 2.9.2. Twisted copper conductors: 300 V CSA FAS minimum 105°C with FT4 rating and in mechanical protection i.e. EMT or flex as specified under Section 26 05 34.00 - CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- 2.9.3. To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.
- 2.9.4. To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.
- 2.9.5. To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.
- 2.9.6. All initiating circuits are to be wired in a DCL-C (i.e. Class A) configuration.
- 2.9.7. All output circuits are to be wired in a Class B configuration, unless otherwise shown on drawings.
- 2.9.8. All wiring between junction boxes and water flow switch, pressure switch, or supervisory switches will be in liquid tight flexible conduit.
- 2.9.9. Where a fire alarm transponder or annunciator located in one fire compartment is connected to a central processing unit or another transponder or annunciator located in a different fire compartment, the data communication link conductors connecting them shall be fire rated for at minimum one (1) hour. Where fire alarm system branch circuits connect transponders and individual fire alarm devices located on another storey, the branch circuits shall be fire rated for at minimum one (1) hour between the transponder and the first fire alarm device located on another storey than the transponder. Provide twisted, shielded pair Mineral-Insulated fire rated cables configured to eliminate interference and cross-talk, except where fire alarm riser diagram clearly illustrates another fire rating approach for particular conductors.
- 2.10. MANUAL ALARM STATIONS
- 2.10.1. Addressable manual pull station.
- .1 Pull lever, break glass rod, semi-flush wall mounted type, single stage, or 2 stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.
 - .2 Provide two pole for direct disconnect of magnetic locking devices local to the devices.
- 2.11. AUTOMATIC ALARM INITIATING DEVICES
- 2.11.1. Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57 deg. C., rate of rise 8.3 deg. C. per minute:
- .1 Electronics to communicate detector's status to addressable module/transponder.
 - .2 Detector address to be programmed on site.
- 2.11.2. Addressable Smoke detector: photo electric:
- .1 Twistlock plug-in type with fixed base.
 - .2 Wire-in base assembly with integral red alarm LED.
 - .3 Auxiliary output contact.
- 2.11.3. Addressable Duct type smoke detectors: photo-electric with sampling tubes:

- .1 Twistlock plug-in type with fixed base.
- .2 Wire-in base assembly with integral red alarm LED.
- .3 Auxiliary output contact.
- .4 Properly sized air sampling tubes.
- 2.11.4. Addressable Beam type detectors: long range and short range:
 - .1 Complete with transmitter and receiver.
 - .2 Short range operating distance of 9-30 meters.
 - .3 Long range operating distance of 30-100 meters.
 - .4 Operating temperatures shall be of -5 to 55 deg. C.
 - .5 The beam detector shall feature alignment LEDs on both the receiver and the transmitter and automatic gain control.
 - .6 Beam detector calibrated test filters, if applicable.
- 2.11.5. Addressable variable-sensitivity smoke detectors:
 - .1 Photo-electric type.
 - .2 Electronics to communicate detector's status to addressable module/transponder.
 - .3 Detector address to be set on detector head in field.
 - .4 Sensitivity settings: 3 settings determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters.
 - .5 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.
 - .6 Auxiliary output contact.
- 2.11.6. Water flow switches: lever and pressure type:
 - .1 Shall have a mechanical alarm transmitted delay adjustable from 0-60 seconds. Initial settings shall be 30-45 seconds. Times will be recorded and submitted to Engineer's Representative.
 - .2 The tamper switch located within the water flow switch shall be wired as per manufacturer's recommendations such that if the housing is open a latching trouble will be initiated.
- 2.11.7. Sprinkler and standpipe valve supervisory switches:
 - .1 The tamper switch located within the supervisory switch shall be wired as per manufacturer's recommendations such that if the housing is open a latching trouble will be initiated.
- 2.12. AUDIBLE SIGNAL DEVICES
- 2.12.1. Horns: 24 V dc, indoor horn type with compression driver, surface mounted.
 - .1 Corrosion, vibration and vermin resistant.
 - .2 Taps: multiple, adjustable with maximum tap output sound level of 100 dB at 3 m.
 - .3 Frequency response: 400 to 4000 Hz.
- 2.12.2. Weatherproof Horns: 24 V dc, for use primarily in mechanical equipment areas, both indoor and outdoor. Horn type with compression driver, surface mounted.
 - .1 Corrosion, vibration and vermin resistant.
 - .2 Frequency response: 400 to 4000 Hz.
 - .3 Complete with weatherproof box as recommended by manufacturer.

- .4 High output 40 mA @ 24 Vdc, Low output 20 mA @ 24 Vdc.

2.13. VISUAL ALARM SIGNAL DEVICES

2.13.1. Visual signal device type: white flashing light, wall mount or ceiling mounted as per drawings.

- .1 Synchronized at one flash per second.
- .2 Flash tube enclosure in clear LEXAN.
- .3 "FIRE" installed red letters.
- .4 Operating on 20-24 V dc.
- .5 Field adjustable for 15 cd, 30 cd, 75 cd, 95 cd, 110 cd, and 115 cd, unless specified otherwise.

2.13.2. Fire do not enter signs and their accessories:

- .1 Compliant with CAN/ULC-S527 "Standard for Control Units for Fire Alarm Systems" and/or CAN/ULC S526 "Standard for Visual Signal Devices for Fire Alarm and Signaling Systems, Including Accessories."
- .2 Powered by fire alarm system; operating on 24 V dc.
- .3 Fire alarm signaling device.

2.14. COMBINATION AUDIBLE AND VISUAL SIGNAL DEVICES

2.14.1. Combination Horn Strobes, complying with the requirements noted above for: Audible Signal Devices and Visual Alarm Signal Devices.

2.15. END-OF-LINE DEVICES

2.15.1. End-of-line devices to control supervisory current in alarm circuits and signalling circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely as indicated.

2.16. REMOTE ANNUNCIATORS

2.16.1. LED type, with designation cards to indicate zones.

2.16.2. Display:

- .1 Alarms for alarm initiating circuits.
- .2 Common supervisory alarm for supervisory initiating circuits.
- .3 Common system trouble.

2.16.3. Trouble buzzer:

- .1 Acknowledging trouble at main panel to silence trouble buzzers in system.

2.16.4. Supervised, with LED test button.

2.16.5. Interconnected with main fire alarm panel at minimum.

2.17. ISOLATION MODULE

2.17.1. Provide isolation modules in accordance with CAN-ULC-S524.

- .1 Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an DCL-C branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the DCL segment branch.

- .2 If a wire-to-wire short occurs, the isolator module shall automatically disconnect the DCL-C segment. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
- .3 The isolation module will provide a single LED that flashes to indicate the isolation module is operating and illuminate steadily to indicate that a short circuit condition has been detected and isolated.

2.18. CENTRAL ALARM MONITORING

2.18.1. Provide Signal Transmitting Unit that utilizes internet connection as primary communications method and cellular network as secondary (back-up) communications method.

- .1 Provide remote antenna for cellular network reception for Signal Transmitting Unit, if location of Signal Transmitting Unit in the building does not facilitate adequate cellular network strength.

2.18.2. Provide a demarcation point; refer to CAN-ULC-S524 Annex E.

2.18.3. Provide monitoring of the system including alarm zones, supervisory zones, trouble signals (excluding primary power failure), and a separate and distinct output for primary power failure (i.e. 120 V power to system). Provide 1 minute delay for transmission of primary power failure signal, to avoid unnecessary signals to signal receiving centre during brief utility company power outages.

2.19. PROGRAMMED FEATURES:

2.19.1. By-pass feature for signalling devices:

- .1 Bypassing of audible devices shall be provided through the programmable keys. The use of the feature is intended for personnel with programming access.

2.19.2. Evacuation feature.

- .1 Evacuation key will be programmed and accessible for any personnel working on the fire alarm panel.

2.20. FIRE ALARM ZONE PASSIVE GRAPHIC DISPLAY:

2.20.1. Layout

- .1 The fire alarm zone passive graphic display shall be completed in the latest version of AutoCAD. The drawing shall indicate all the building floor plans and respective fire alarm zones with the description corresponding to the zone indication at the fire alarm control panel and annunciator.
- .2 The fire alarm zones indicated for each floor shall be clearly defined with borders to indicate zone separation.
- .3 The general font style shall be Helvetica upper case. Text size:
 - .1 6 mm in height for building name and 4.5 mm for municipal address and floor plans all coloured green.
 - .2 Main entrance arrow and text shall be Romans forward slant style 3 mm in height coloured cyan.
 - .3 Fire alarm zones and equipment notes shall be 3 mm in height coloured red.
 - .4 Fire hose cabinets shall be Romans forward slant style 3 mm in height coloured cyan.
- .4 Graphic display colours.
 - .1 Outline of building plan to be black line on white background.

- .2 All egress corridors shall be clearly defined with Red colour #13 solid hatch pattern.
- .3 All stairs and elevators shall be indicated using yellow solid hatch pattern.
- .5 Include the following information on the graphic display:
 - .1 A north arrow on the upper left corner of the zone graphic.
 - .2 "You are here" location in Red and properly orientated to the viewer when standing in front of the graphic.
 - .3 A drawing scale graph and drawing file number located in the lower right of the zone graphic.
 - .4 Building name and number at the bottom centre of the graphic display with municipal address indicated on the next line below.
 - .5 The main building entrance and street reference.
 - .6 Location of fire alarm control panel and annunciators, fire department connections, fire pumps, fire hose cabinets and associated standpipe and sprinkler valves.
 - .7 Location of main gas valve, suppression systems, chemical storage vaults, major mechanical equipment and duct smoke detectors indicating zone number.
 - .8 Substation and transformer locations indicating primary and secondary voltages.
- 2.20.2. Construction
 - .1 The graphic display shall be:
 - .1 Printed on white heavy weight 40lb. coated bond with colour UV inks, laminated on 1.5 mm styrene board and covered with clear Lexan.
 - .2 Standard passive graphic display size ranges from 8.5"x11" to 23"x35". The final size of the graphic may vary depending on the layout requirements and site conditions.
 - .2 Trim to be No. 4 stainless steel finish.
- 2.20.3. Location
 - .1 Install graphic display adjacent to each fire alarm annunciator panel and the fire alarm control panel.
 - .2 Graphic display to be fixed to the building structure or fire alarm control panel enclosure using tamper proof screws at each corner and at the midpoint on all four sides.
- 2.20.4. Approval Drawings
 - .1 Submit three full colour print copies of the passive display graphic for review by the Owner, the Engineer's Representative and the local fire department.
 - .2 Include the final approved zone graphic drawing in electronic format with the as-built drawings.
- 2.21. ANCILLARY DEVICES
- 2.21.1. Remote relay unit to initiate fan shutdown, magnetic door locks and door hold open devices.
- 2.22. STI STEEL WEB STOPPERS, DETECTOR COVERS.
- 2.22.1. Provide STI 9600 series detector cover for areas where sporting events or similar activities avail. STI STOPPER 2 & WEATHER PROOF STOPPER 2, COVERS FOR MANUAL STATIONS.

- 2.23.1. Provide STI Stopper 2 1100 series manual station covers for all vandal resistant locations identified on the electrical and architectural drawings.
- 2.23.2. Provide Weather Proof Stopper 2 1200 (flush mount) or 3100 (surface mount) series manual station covers for all weather proof locations and outdoor applications identified on the electrical and architectural drawings.
- 2.24. RELAY BASE, FOR FIRE DETECTORS.
 - 2.24.1. Provide power along with the relay base detector such that the device that is being controlled with the normally open or normally closed relay base may operate or function. Power requirements and relay condition to be determined on site.
- 2.25. MANUFACTURERS
 - 2.25.1. The following are acceptable manufacturers:
 - .1 Chubb Edwards.
 - .2 Johnson Controls Simplex.
 - .3 Mircom.
 - .4 Siemens.
 - .5 Notifier.
 - .6 Johnson Controls Autocall.
- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Install systems in accordance with CAN/ULC-S524.
 - 3.1.2. Install central control unit and connect to ac power supply.
 - 3.1.3. Install manual alarm stations and connect to alarm circuit wiring.
 - 3.1.4. Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts. Install duct type detectors complete with sampling tubes. Ensure duct type smoke detectors are installed far enough away from humidifiers to avoid false alarms; coordinate location of duct type smoke detector with Mechanical Contractor. If false alarms occur, relocate duct type smoke detector at no cost to the Owner.
 - 3.1.5. Connect alarm circuits to main control panel.
 - 3.1.6. Install bells, horns and visual signal devices and connect to signalling circuits.
 - 3.1.7. Connect signalling circuits to main control panel.
 - 3.1.8. Adjust visual signal device candela ratings upward, where required to meet coverage. Utilize spare visual signal device circuit capacity required in Part 2.
 - 3.1.9. Install end-of-line devices.
 - 3.1.10. Install remote annunciator panels and connect to annunciator circuit wiring.
 - 3.1.11. Install door releasing devices.
 - 3.1.12. Install remote relay units to control fan shut down.

- 3.1.13. Where smoke dampers or combination smoke and fire dampers are shown, terminate damper position monitoring wiring for both fire alarm system and building automation system on damper actuator position end switches. Building automation system wiring to damper location will be provided by Mechanical Division.
- 3.1.14. Sprinkler system: wire alarm and supervisory switches and connect to control panel.
 - .1 Sprinkler devices should be wired such that opening of a device will cause a trouble on an alarming device or a supervisory on a supervising device.
 - .2 Where mechanical/sprinkler contractor makes revisions to the base design, electrical contractor shall coordinate any revisions to fire protection system directly with the mechanical/sprinkler contractor at no cost to the owner and update as-built drawings accordingly.
- 3.1.15. Room detection system (where applicable):
 - .1 Install detectors. Make necessary connections between room detection panel and main fire alarm panel.
 - .2 Locate and install audible signals and visual alarms.
 - .3 Locate and install detectors under raised floor. Fasten to steel brackets approximately 300 mm above sub-floor level to clear cables and conduits.
- 3.1.16. Connect fire suppression systems to control panel.
- 3.1.17. 'T-Tapping' is not permitted.
- 3.1.18. For audible and visual signal devices in spaces subject to future tenant renovations, install devices in surface mounted boxes and leave 3 m of extra wiring coiled up in the box to allow the devices to be lowered / relocated to suit the tenant fit up ceiling and wall locations.
- 3.1.19. Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- 3.1.20. Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- 3.1.21. Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.
- 3.1.22. Install smoke and smoke/CO alarm in accordance with CAN/ULC-S553.
 - .1 Where more than one smoke (or smoke/CO) alarm is installed within a dwelling unit, interconnect the wiring such that actuation of one smoke (or smoke/CO) alarm will cause all the smoke (or smoke/CO) alarms within the dwelling unit to sound.
- 3.1.23. Where devices are to be installed in environments where the temperature can drop below 0°C (or below the addressable device temperature rating), an appropriately rated conventional device is to be installed.
 - .1 Provide and install an addressable input module remotely located in a conditioned environment suitable for the device temperature rating.
 - .2 Connect the conventional device(s) to addressable input module(s) as necessary to monitor the status of the conventional device.
- 3.1.24. Where shown on Drawings, install "Fire do not enter signs" in accordance with the requirements of CAN/ULC-S524.

3.2. FIELD QUALITY CONTROL AND COMMISSIONING

- 3.2.1. Perform tests and verification in accordance with Section 26 08 01.00 - TECHNICAL SERVICES DIVISION STARTUP SERVICE.
- 3.2.2. The installing contractor is responsible for hiring and coordinating with the manufacturer to perform the following:
- .1 Testing of system to CAN/ULC-S536 prior to performing verification.
 - .2 Partial verification inspection to CAN/ULC-S537 and reports as required for partial occupancy.
 - .3 Complete an entire building test to CAN/ULC-S536 and provide detailed report. Provide a full verification inspection and test report at the end of the project. Cumulative partial verification reports do not constitute a full verification.
- 3.2.3. All fire alarm test and verification reports are to be submitted with a covering letter from the manufacturer clearly stating that there are no deficiencies with the installation prior to releasing the respective area for occupancy.
- 3.2.4. Include fire alarm audible signal device sound pressure levels, on a space by space / room by room basis, as part of the fire alarm verification report.
- .1 Test sound pressure levels when any intervening doors between the device and the rest of the floor area are closed, in accordance with the intent and requirements of the Building Code.

3.3. LIFE SAFETY INTEGRATION TESTING

- 3.3.1. The fire alarm contractor and fire alarm manufacturer shall participate in the coordination and testing work associated with the Integrated Testing Plan (ITP), as described in more detail in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS. All work shall be coordinated with the Integrated Testing Coordinator (ITC). The work shall include but not be limited to:
- .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
 - .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
 - .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001.
 - .4 Provide fire alarm verification report along with all other documentation requested by the ITC as it relates to the electrical systems in conformance with CAN/ULC-S1001.

3.4. CENTRAL ALARM MONITORING

- 3.4.1. Locate Signal Transmitting Unit in same room as main fire alarm panel, unless shown otherwise on Drawings.
- 3.4.2. Provide a data connection from the Owner's network for internet access for central monitoring.
- 3.4.3. Coordinate with the Owner's Fire Alarm Monitoring Company and install power, conduit and wiring to the Signal Transmitting Unit in compliance with CAN/ULC-S559 and CAN/ULC S561.
- 3.4.4. Facilitate conversation between Owner and Owner's preferred fire alarm central alarm monitoring service to ensure that central monitoring service is provided in time for completion of fire alarm scope and Project occupancy.

END OF SECTION

Attachment A Luminaire Schedule

ATTACHMENT A

LUMINAIRE SCHEDULE

END OF SECTION Attachment B Fire Alarm Schedule

LUMINAIRE SCHEDULE				File Name:		Attachment A - Luminaires Schedule_R01		Smith + Andersen	
Project Name: Sterling Hall Addition									
Project number: 00036.010.001									
TYPE	VOLT.	LAMP(S)	DIMENSIONS	DESCRIPTION	DRIVERS/POWER SUPPLY	MANUFACTURER/CATALOGUE NUMBER	MINIMUM PERFORMANCE REQUIRED (DELIVERED)	LOCATED	
LED: AMBIENT / GENERAL PURPOSE LIGHTING									
L1A	120 V	4.8 W/ft. LED (3500 K) 80 CRI	5" W x 4.625" H See length on electrical drawings	Recessed T-Bar Straight and Narrow LED fixture. Extruded aluminum body. High transmission diffuser. Matte finish using electrostatically applied polyester powder coat paint. T-Bar mounting brackets/clips. LED modules are driven using universal voltage switch mode LED drivers. Certified to UL and CUL standards.	0-10V Dimming	• Neo-Ray: Define 4	575 lumens/ft	T-bar Ceilings: Classrooms, Corridors and offices	
L1B	120 V	6.8 W/ft. LED (3500 K) 80 CRI	5" W x 4.625" H See length on electrical drawings	Recessed T-Bar Straight and Narrow LED fixture. Extruded aluminum body. High transmission diffuser. Matte finish using electrostatically applied polyester powder coat paint. T-Bar mounting brackets/clips. LED modules are driven using universal voltage switch mode LED drivers. Certified to UL and CUL standards.	0-10V Dimming	• Neo-Ray: Define 4	795 lumens/ft	T-bar Ceilings: Classrooms, Corridors and offices	
L1C	120 V	10.6 W/ft. LED (3500 K) 80 CRI	5" W x 4.625" H See length on electrical drawings	Recessed T-Bar Straight and Narrow LED fixture. Extruded aluminum body. High transmission diffuser. Matte finish using electrostatically applied polyester powder coat paint. T-Bar mounting brackets/clips. LED modules are driven using universal voltage switch mode LED drivers. Certified to UL and CUL standards.	0-10V Dimming	• Neo-Ray: Define 4	1195 lumens/ft	T-bar Ceilings: Classrooms, Corridors and offices	
L2	120 V	10.6 W/ft. LED (3000 K) 80 CRI	4.25" W x 4.625" H See length on electrical drawings	Recessed on Drywall Ceiling Straight and Narrow LED fixture. Continuous row. Extruded aluminum housing. High transmission diffuser. Flush optic diffuser. Matte finish using electrostatically applied polyester powder coat paint. LED modules are driven using universal voltage switch mode LED drivers. Certified to UL and CUL standards. Contractor to install asymmetric optics towards the floor.	0-10V Dimming	• Neo-Ray: Define 4	1195 lumens/ft	Drywall ceiling: Corridors	
L3A	120 V	13.7 W LED (3500 K) 80 CRI	4-5/16" dia. aperture, 5-7/16" trim, 6-5/8" depth	Recessed round 4" LED Open Down light. Self-flanged, semi specular, spun 0.050" thick aluminum lower reflector. Medium wide light distribution. Universal mounting bracket, adjusts 5" vertically from above and below ceiling. Specular Clear finish. Light engine and driver accessible through aperture. Fully serviceable and upgradeable lensed LED light engine. CSA certified to meet US and Canadian standards; wet location, covered ceiling.	0-10V Dimming	• Gotham: EVO 4	1527 lumens	Drywall ceiling: Washrooms, Classrooms	
L3B	120 V	25.7 W LED (3500 K) 80 CRI	4-5/16" dia. aperture, 5-7/16" trim, 6-5/8" depth	Recessed round 4" LED Open Down light. Self-flanged, semi specular, spun 0.050" thick aluminum lower reflector. Medium wide light distribution. Universal mounting bracket, adjusts 5" vertically from above and below ceiling. Specular Clear finish. Light engine and driver accessible through aperture. Fully serviceable and upgradeable lensed LED light engine. CSA certified to meet US and Canadian standards; wet location, covered ceiling.	0-10V Dimming	• Gotham: EVO 4	2580 lumens	Drywall ceiling: Washrooms, Classrooms	
L3C	120 V	31.2 W LED (3500 K) 80 CRI	4-5/16" dia. aperture, 5-7/16" trim, 6-5/8" depth	Recessed round 4" LED Open Down light. Self-flanged, semi specular, spun 0.050" thick aluminum lower reflector. Medium wide light distribution. Universal mounting bracket, adjusts 5" vertically from above and below ceiling. Specular Clear finish. Light engine and driver accessible through aperture. Fully serviceable and upgradeable lensed LED light engine. CSA certified to meet US and Canadian standards; wet location, covered ceiling.	0-10V Dimming	• Gotham: EVO 4	3110 lumens	Drywal ceiling: Washrooms, Classrooms, Meeting room	
L3D	120 V	38.4 W LED (3500 K) 80CRI	4-5/16" dia. aperture, 5-7/16" trim, 6-5/8" depth	Recessed round 4" LED Open Down light. Self-flanged, semi specular, spun 0.050" thick aluminum lower reflector. Medium wide light distribution. Universal mounting bracket, adjusts 5" vertically from above and below ceiling. Specular Clear finish. Light engine and driver accessible through aperture. Fully serviceable and upgradeable lensed LED light engine. CSA certified to meet US and Canadian standards; wet location, covered ceiling.	0-10V Dimming	• Gotham: EVO 4	3612 lumens	Drywall ceiling: Washrooms, Classrooms	
L4A	120 V	6.7 W/ft. LED (3500 K) 80 CRI	2" W x 4.13" H See length on electrical and architectural drawings	Pendant Direct Narrow Linear LED fixture. Extruded aluminum housing. High transmission diffuser. Matte finish using electrostatically applied polyester powder coat paint. LED modules are driven using universal voltage switch mode LED drivers. Certified to UL and CUL standards.	0-10V Dimming	• Neo-Ray: Define 2	675 lumens/ft	Wooden Slat: c100 Corridor	
L4B	120 V	10.6 W/ft. LED (3500 K) 80 CRI	2" W x 4.13" H See length on electrical and architectural drawings	Pendant Direct Narrow Linear LED fixture. Extruded aluminum housing. High transmission diffuser. Matte finish using electrostatically applied polyester powder coat paint. LED modules are driven using universal voltage switch mode LED drivers. Certified to UL and CUL standards.	0-10V Dimming	• Neo-Ray: Define 2	1005 lumens/ft	Exposed and drywall ceiling: Classrooms, corridors, breakout rooms	

[illegible]

LUMINAIRE SCHEDULE				File Name:	Attachment A - Luminaires Schedule_R01	Smith + Andersen		
Project Name: Sterling Hall Addition								
Project number: 00036.010.001								
TYPE	VOLT.	LAMP(S)	DIMENSIONS	DESCRIPTION	DRIVERS/POWER SUPPLY	MANUFACTURER/CATALOGUE NUMBER	MINIMUM PERFORMANCE REQUIRED (DELIVERED)	LOCATED
LS-1	120/277 V	115W LED (3000 K) 90 CRI	W: 6" H: 3.5" L: 28"	Singlehead pole mount fixture Clearsite lens, type 4 distribution. Dark sky approved. Pole to be NON-tapered, galvanized steel, 6" square, 12 ft. tall, internally dampened to eliminate second mode vibrations, standard colour finish to match fixture head colour. Pole to be mounted on 1 ft. high concrete base above grade. . Pole is to be complete with factory installed dampeners for resonance vibration cancelation.	Dimmable 0-10V	Lumenpulse Lumenblade pole mount BDLM	7210 lumens	Pole lights
LS-1A	120/277 V	115W LED (3000 K) 90 CRI	W: 6" H: 3.5" L: 28"	Doublehead pole mount fixture Clearsite lens, type 4 distribution. Dark sky approved. Pole to be NON-tapered, galvanized steel, 6" square, 12 ft. tall, internally dampened to eliminate second mode vibrations, standard colour finish to match fixture head colour. Pole to be mounted on 1 ft. high concrete base above grade. . Pole is to be complete with factory installed dampeners for resonance vibration cancelation.	Dimmable 0-10V	Lumenpulse Lumenblade pole mount BDLM	7210 lumens/fixture	Pole lights
LS-2	120 V	25W LED (3000 K) 90 CRI	W: 14.7" H: 3" L: 5.1"	Wall mounted fixture: Half frosted site lens. Type III distribution. Dark Sky approved.	Dimmable 0-10V	Lumenpulse Lumenblade - BLDS W1H series	2000 lumens	Wall mounted fixture
LS-3	120 V	51W LED (3000 K) 80 CRI	W: 8" H: 39" L: 6"	Bollard Fixture: Clearsite lens, single head. Type III distribution. Dark Sky approved.	Dimmable 0-10V	Lumenpulse Lumenblade - BLDB W1H series	1000 lumens	Bollard- Site
LS-4	120 V	15W LED (3000 K) 80 CRI	dia: 4.61" H: 3.66"	4" Recessed Downlight Symmetric medium beam. CSA listed for wet locations. Impact resistant.	Dimmable 0-10V	DOC110 LED New Construction series	1282.4 lumens	Outdoor Canopies
EMERGENCY LIGHTING								
X1	AC 120/ 347 V DC 6, 12, 24 V	LED		Architectural Edge-lit Pictogram Exit Sign, slim-profile extruded aluminum housing, high-output LED. Universal surface mounting - wall, ceiling, or end mount. Extruded acrylic panel with pictogram legend. Refer to drawings for mounting, number of faces and direction of arrows. AC/Universal DC backup.		• Lumacell: LAE Series • Emergi-Lite: EAE Series • Beghelli: Ottica RM Series • Aimlite: RPEL Series • Stanpro: RMEA Series		See drawings
X2	AC 120/ 347 V DC 6, 12, 24 V	LED		Weatherproof surface mounted cast aluminum pictogram exit sign, high output LED, protected by high abuse clear polycarbonate c/w fully gasketed housing and tamper resistant screws. Wet location listed. Suitable for cold weather application. NEMA 4X rated. Refer to drawings for mounting, number of faces and direction of arrows. AC / Universal DC backup.		• Lumacell: LN Series • Emergi-Lite: EN Series • Beghelli: Fortezza RM Series • Stanpro: RMR Series • Aimlite: RPWP Series		See drawings

LUMINAIRE SCHEDULE

Project Name: Sterling Hall Addition

Project number: 00036.010.001

File Name:

Attachment A - Luminaires Schedule_R01

Smith + Andersen

TYPE	VOLT.	LAMP(S)	DIMENSIONS	DESCRIPTION	DRIVERS/POWER SUPPLY	MANUFACTURER/CATALOGUE NUMBER	MINIMUM PERFORMANCE REQUIRED (DELIVERED)	LOCATED
NOTES: 1. All luminaires need to be consistent on technology and must match reference standard description regardless of catalogue number. Where finishes are not indicated, allow for special finish. Manufacturer/Catalogue number not listed will not be considered. 2. The Electrical Contractor is responsible for the supply and installation of all fixed per unit cost luminaires as part of the base electrical contract. The Electrical Contractor is responsible for the installation of all cash allowance luminaires as part of the base electrical contract. Refer to specification 16505 or 26 51 13.00 for more details. 3. LEDs are to be latest technology to provide maximum lumens, binned, best colour and longest life at time of purchase. Drivers are to be the latest technology at time of purchase. 4. LED luminaire dimensions listed are the maximum size allowed. Luminaires provided can be smaller than the dimension listed. 5. All luminaire diameters and depths listed are the maximum size allowed. Luminaires provided can be smaller than the dimension listed. 6. All LED luminaires that present signs of failure on site, within the warranty period, must be replaced at no cost to the owner. If temporary luminaires are required to replace any failed LED luminaires, during the waiting time for parts (i.e. drivers, boards, heat sinks, etc.), the labour cost including installation, temporary luminaire supply, temporary luminaire removal and reinstallation of the LED fixture must be provided at no cost to the owner. Additional electrical costs, associated with higher wattage temporary luminaires, must be reimbursed with interest to the owner by the manufacturer. 7. In case of failure of an LED luminaire, whether complete failure or partial failure, a independent third party testing Laboratory (approved by Smith + Andersen) shall be commissioned by the manufacturer or vendor to perform tests on samples taken from the failed luminaires installed on corresponding site. All reporting including the test results must be submitted to Smith + Andersen for evaluation and final approval. 8. Any additional time (related to luminaire manufacturing issues) spent by Smith + Andersen will be billed at our hourly rates to the manufacturer or vendor. 9. All LED parts and accessories must be replaceable on site without removal of the luminaire. 10. Equivalents will only be considered at Smith + Andersen discretion prior to tender close. Sample must be supplied with plug and cord for mock-up. 11. When a mock-up is requested, the full order of luminaires are on hold until approval and verification of the mock-up findings. 12. Poles and bases are to be designed to accommodate wind conditions to avoid damage due to wind-induced vibrations. Shop drawings are to be signed by a structural engineer registered in the local jurisdiction. 13. Alternates are not acceptable for all luminaires . 14. Contractor shall be responsible for providing the required quantity of LED drivers to suit the luminaire layout shown on the Drawings.								

ATTACHMENT B

FIRE ALARM SCHEDULE

END OF SECTION

PROJECT NAME: STERLING HALL SCHOOL
Project number: 00036.010.E.001
Date: 2026.07.03

Smith + Andersen



FIRE ALARM SCHEDULE

Zone No.	Alarm	Supervisory	Control/Monitor	Annunciator Label		Description
					Mech. Labels	
Alarm Zones						
AXX-0X	X			ZN1 BASEMENT		DETECTION DEVICES
AXX-0X	X			ZN2 FIRST FLOOR EAST		DETECTION DEVICES
AXX-0X	X			ZN3 FIRST FLOOR WEST		DETECTION DEVICES
AXX-0X	X			ZN4 EAST CORRIDOR PORTABLE		DETECTION DEVICES
AXX-0X	X			ZN5 OUTDOOR STORAGE		DETECTION DEVICES
AXX-0X	X			ZN6 KITCHEN HOOD		DETECTION DEVICES
AXX-0X	X			ZN7 EAST PORTABLE		DETECTION DEVICES
AXX-0X	X			ZN8 LIBRARY		DETECTION DEVICES
AXX-0X	X			ZN9 MAIN GYM AND CHANGE ROOM		DETECTION DEVICES
AXX-0X	X			ZN10 MAIN GYM CORRIDOR		DETECTION DEVICES
AXX-0X	X			ZN11 WEST ADDITION FLOW SWITCH	FS	SPRINKLER DEVICE
AXX-0X	X			ZN12 RTU#1 DUCT DETECTOR		SMOKE DETECTION
AXX-0X	X			ZN14 RTU #3 DUCT DETECTOR		SMOKE DETECTION
AXX-0X	X			ZN15 RTU#4 DUCT DETECTOR		SMOKE DETECTION
AXX-0X	X			ZN16 CRAWL SPACE FLOW SWITCH	FS	SPRINKLER DEVICE
AXX-0X	X			ZONE 17 NORTH ADDITION FLOW SWITCH	FS	SPRINKLER DEVICE
AXX-0X	X			ZONE 18 TOP OF STAIR FROM BASEMENT		SMOKE DETECTION
AXX-0X	X			ZONE 19 TOP OF STR FROM BASE TO OUTSIDE		SMOKE DETECTION
AXX-0X	X			ZONE 20 FOOD PREP ROOM		DETECTION DEVICES
AXX-0X	X			ZONE 21 RTU 5		DETECTION DEVICES
AXX-0X	X			ZONE 22 RTU 6		DETECTION DEVICES
AXX-0X	X			ZONE33 STANDPIPE FLOW #1	FS	SPRINKLER DEVICE
AXX-0X	X			ZONE34 STANDPIPE FLOW #1	FS	SPRINKLER DEVICE
AXX-0X	X			ZONE 35 1ST FLR SOUTHWEST		DETECTION DEVICES
AXX-0X	X			ZONE36 1ST FLR SOUTHWEST SPRINKLER FLOW	FS	SPRINKLER DEVICE
AXX-0X	X			ZONE 37 SPARE		-
AXX-0X	X			ZONE 38 SPARE		-
AXX-0X	X			ZONE 40 1ST FLR SOUTHWEST SPRINKLER LP	FS	SPRINKLER DEVICE
AXX-0X	X			2026 WEST ADDITION	FS	SPRINKLER DEVICE
AXX-0X	X			LOWER LEVEL ADDITION		DETECTION DEVICES
AXX-0X	X			LOWER LEVEL ADDITION FLOW SWITCH	FS	SPRINKLER DEVICE
AXX-0X	X			LOWER LEVEL WINDOW SPRINKLERS	FS	SPRINKLER DEVICE
AXX-0X	X			GROUND FLOOR ADDITION		DETECTION DEVICES
AXX-0X	X			GROUND FLOOR ADDITION FLOW SWITCH	FS	SPRINKLER DEVICE
AXX-0X	X			GROUND FLOOR ADDITION WINDOW SPRINKLERS	FS	SPRINKLER DEVICE
AXX-0X	X			SECOND FLOOR ADDITION		DETECTION DEVICES
AXX-0X	X			SECOND FLOOR ADDITION FLOW SWITCH	FS	SPRINKLER DEVICE
AXX-0X	X			SECOND FLOOR ADDITION WINDOW SPRINKLERS	FS	SPRINKLER DEVICE
AXX-0X	X			ELEV E-00 PIT DETECTOR		DETECTION DEVICES
AXX-0X	X			ELEV E-00 PIT TOP OF SHAFT DETECTOR		DETECTION DEVICES
AXX-0X	X			ELEVATOR ROOM 004		DETECTION DEVICES
AXX-0X	X			STAIR A		DETECTION DEVICES
AXX-0X	X			STAIR B		DETECTION DEVICES
AXX-0X	X			STAIR C		DETECTION DEVICES
AXX-0X	X			RTU- 01	FASD	DUCT SMOKE DETECTOR
AXX-0X	X			RTU- 02	FASD	DUCT SMOKE DETECTOR
Supervisory Zones						
SVXX-0X		X		ZN25 WEST ADDITION SHUTOFF	SV 3	SPRINKLER DEVICE
SVXX-0X		X		ZN26 MAIN LOW PRESSURE	PS	SPRINKLER DEVICE
SVXX-0X		X		ZN27 STANDPIPE SHUTOFF	SV 4	SPRINKLER DEVICE
SVXX-0X		X		ZN28 NORTH ADDITION	SV 6	SPRINKLER DEVICE

PROJECT NAME: STERLING HALL SCHOOL
Project number: 00036.010.E.001
Date: 2026.07.03

Smith + Andersen



FIRE ALARM SCHEDULE

Zone No.	Alarm	Supervisory	Control/Monitor	Annunciator Label		Description
					Mech. Labels	
SVXX-0X		X		ZN29 NORTH ADDITION LOW PRESSURE	PS	SPRINKLER DEVICE
SVXX-0X		X		ZN30 CRAWL SPACE SHUTOFF	SV 5	SPRINKLER DEVICE
SVXX-0X		X		ZN31 CRAWL SPACE LOW PRESSURE	PS	SPRINKLER DEVICE
SVXX-0X		X		ZONE 23 SPRINKLER MAIN CONTROL VLV-SV-1	SV	SPRINKLER DEVICE
SVXX-0X		X		ZONE 24 STANDPIPE SHUT-OFF VALVE SV-2	SV	SPRINKLER DEVICE
SVXX-0X		X		ZONE 39 1ST FLR SOUTHWEST SPRINKLER VALVE	SV	SPRINKLER DEVICE
SVXX-0X		X		2026 WEST ADDITION SPRINKLER CONTROL VALVE	SV	SPRINKLER DEVICE
SVXX-0X		X		LOWER LEVEL ADDITION CONTROL VALVE	SV	SPRINKLER DEVICE
SVXX-0X		X		LOWER LEVEL ADDITION WINDOW SPRINKLERS	SV	SPRINKLER DEVICE
SVXX-0X		X		GROUND FLOOR ADDITION CONTROL VALVE	SV	SPRINKLER DEVICE
SVXX-0X		X		GROUND FLOOR ADDITION WINDOW SPRINKLERS	SV	SPRINKLER DEVICE
SVXX-0X		X		SECOND FLOOR ADDITION CONTROL VALVE	SV	SPRINKLER DEVICE
SVXX-0X		X		SECOND FLOOR ADDITION WINDOW SPRINKLERS	SV	SPRINKLER DEVICE
Auxiliary Control/Monitoring points						
C-XX			X	AV SOUND SYSTEM AUDIO MUTE ACTIVATION INTERFACE		Aux. Contact (Control)
C-XX			X	DOOR HOLD OPEN RELEASE		Aux. Contact (Control)
C-XX			X	SIGNAL TO BAS		Aux. Contact (Control)
C-XX			X	SIGNAL TO FIRE DEPARTMENT		Aux. Contact (Control)
C-XX			X	FIRE SHUTTER RELEASE		Aux. Contact (Control)
C-XX			X	LIGHTING CONTROL INTERFACE		Aux. Contact (Control)
C-XX			X	SECURITY MASTER KEY SWITCH		Aux. Contact (Control)
C-XX			X	ROOF TOP UNIT FASD	RTU-01	Aux. Contact (Control)
C-XX			X	ROOF TOP UNIT FASD	RTU-02	Aux. Contact (Control)
C-XX			X	ELEVATOR CONTROL FA MACHINE ROOM STATUS		Aux. Contact (Control)
C-XX			X	ELEVATOR CONTROL FA RECALL FLOOR STATUS		Aux. Contact (Control)
C-XX			X	ELEVATOR CONTROL FA ALT RECALL FLOOR STATUS		Aux. Contact (Control)
C-XX			X	ELEVATOR CONTROL FA TOP OF SHAFT STATUS		Aux. Contact (Control)
C-XX			X	ELEVATOR CONTROL FA PIT DETECTOR STATUS		Aux. Contact (Control)
C-XX			X	ELEVATOR RECALL		Aux. Contact (Control)
C-XX			X	EXTERIOR CONVENTIONAL PULL STATION.		Aux. Contact (Monitor)
Accessories						
			X	FIRE ALARM ANNUNCIATOR		
			x	FIRE ALARM PASSIVE GRAPHIC		
External Tie-ins						
1.	Connect to Air Handling Unit Controller					
2.	Third Party Monitoring Station					
3.	Connect to Elevator Controller					
4.	Connect to Existing Building Fire Alarm Contoller					
5.	Connect to Security System Controller					
Notes:						

Attachment C Battery Unit Schedule

ATTACHMENT C

BATTERY UNIT SCHEDULE

END OF SECTION Attachment D Panel Schedules

BATTERY UNIT SCHEDULEPROJECT NAME: **STERLING HALL ADDITION**

PROJECT #: 00036-010-E-001

Smith + Andersen



UNIT DESIGNATION	LOCATION	SINGLE HEAD	DOUBLE HEAD	EXIT SIGNS	SPARE CAPACITY (%)	MINIMUM CONNECTED LOAD (W)	LENGTH OF RUNTIME REQUIRED (hr)
		LOAD PER HEAD (12 W) QUANTITY	LOAD PER SET (24 W) QUANTITY	LOAD PER SIGN (5 W) QUANTITY			
BU-0.1	ELEC CLOSET 003	3	4	4	20%	182.4	0.5
BU-0.2	MECHANICAL 005	2	5	1	20%	178.8	0.5
					20%		0.5
BU-1.1	EX MECHANICAL 110	4	8	9	20%	342	0.5
BU-1.5.1	RECEPTION 102	1	16	12	20%	547.2	0.5
BU-1.5.2	IT/STORAGE 123	4	15	16	20%	585.6	0.5
BU-2.1	ELECTRICAL 204	5	3	10	20%	218.4	0.5
BU-2.2	ELECTRICAL 204	1	9	11	20%	339.6	0.5
					20%		0.5
					20%		

NOTES:

1. Provide all mounting shelves for installation of battery units. Size to suit.
2. Provide breaker lock-on devices for all circuit(s) feeding battery units.
3. Operating time for generator and automatic transfer switch rooms to be 2 hrs minimum per CSA C282 - Emergency Electrical Power Supply for Buildings.
4. Provide wireguards for battery units and remote heads as shown/indicated on the drawings.

ATTACHMENT D
PANEL SCHEDULES

END OF SECTION

Panel:

LP-0B

Project Name:

STERLING HALL

Project #:

00036.010.E001

Description:

Date:

Location:

ELEC. CLOSET 003

Fed From:

Smith + Andersen

CCT No.	Connection/Breaker Type - Circuit Description	BKR [A]	Pole s	DF [%]	Estimated Load [VA]	A		B		C		Estimated Load [VA]	DF [%]	Pole s	BKR [A]	Connection/Breaker Type - Circuit Description	CCT No.
1	LTG - STAIR C	20	1	100.0	1220	1220											2
3	LTG - CORRIDOR - C000	20	1	100.0	1399			1399									4
5	LTG -STAIR B	20	1	100.0	210					210							6
7	LTG - FLEXIBLE SPACE 002	20	1	100.0	564	564											8
9	LTG - ELEVATOR E-00	20	1	100.0	32			32									10
11																	12
13																	14
15																	16
17																	18
19																	20
21																	22
23																	24
25																	26
27																	28
29																	30
31																	32
33																	34
35																	36

Connection/Breaker Type Legend:

	BAS - Building Automation Systems	SPD - Surge Protection Device	M - Motor	LTG - Lighting
	GFCI - Ground Fault Circuit Interrupter	BLO - Breaker Lock-On Device	D.F. - Demand Factor	HID - High Intensity Discharge Lighting Breaker
	AFCI - Arc Fault Circuit Interrupter	R.C. - Relay Controlled	REC - Receptacle	D.C. - Direct Connection

Panel Options: Refer to Panel Notes for selected Options				Panel Totals				Panel Parameters			
1	CSA Enclosure Rating			Estimated Load A [kVA]		1.78 kVA		Voltage		120/208 Wye	
2	Feed Through			Estimated Load B [kVA]		1.43 kVA		PHASE:		3	
3	Sub Feed			Estimated Load C [kVA]		0.21 kVA		WIRES:		4	
4	Main Breaker			Total Est. Demand [kVA]:		3.43 kVA		MAINS [A]:		100 A	
5	200% Rated Neutral Bus			Total Conn. Load [kVA]:		3.43 kVA		MAIN BREAKER [A], 1 = not required		1	
6	Isolated Ground Bus							I.C. [kA]:			
7	Plug in Breaker			Estimated Current A [A]		15 A					
8	SPD			Estimated Current B [A]		12 A					
				Estimated Current C [A]		2 A					

Notes:

1) Panel Enclsoure to be Sprinklerproof.
2) Panels greater than 66 circuits shall be double tub.
3) Surge Protection Device (SPD) to be in a separate barrered enclosure with separate cover.
4) Terminate circuits for BAS in 4"x4" junction box 10' from panel.

ISSUED FOR TENDER

2026.07.08

Panel:

LP-1B

Project Name:

STERLING HALL

Project #:

00036.010.E001

Description:

Date:

Location:

ELECTRICAL 204

Fed From:

Smith + Andersen

CCT No.	Connection/Breaker Type - Circuit Description	BKR [A]	Pole s	DF [%]	Estimated Load [VA]	A		B		C		Estimated Load [VA]	DF [%]	Pole s	BKR [A]	Connection/Breaker Type - Circuit Description	CCT No.
1	LTG - IT STORAGE 223	20	1	100.0	1103	1103	720					720	100.0	1	20	LTG - WOODEN SLAT CEILING	2
3	LTG - EXISTING MECH ROOM 110	20	1	100.0	935			935	160			160	100.0	1	20	LTG - STAIR A	4
5	LTG - RECEPTION ROOM 102	20	1	100.0	1099					1099	637	637	100.0	1	20	LTG - CORRIDOR -C120	6
7	LTG - STAIR A1 ST-A1	20	1	100.0	202	202	387					387	100.0	1	20	LTG - CLASSROOM 129	8
9	LTG - MAIN VESTIBULE AND CORRIDOR	20	1	100.0	378			378	321			321	100.0	1	20	LTG - BREAKOUT 128A	10
11	LTG - ELEVATOR E-00	20	1	100.0	32					32	370	370	100.0	1	20	LTG - CLASSROOM 127	12
13	LTG - CORRIDOR C101	20	1	100.0	600	600	611					611	100.0	1	20	LTG - STUDENT WASHROOM 126	14
15	LTG -OFFICE 111 AND 112 AND PRAYER ROOM 113	20	1	100.0	236			236									16
17	LTG - CORRIDOR - C102	20	1	100.0	822					822							18
19	LTG - VESTIBULE 114	20	1	100.0	70	70											20
21	LTG - CORRIDOR - C120	20	1	100.0	281			281									22
23	LTG - ELEV E-00	20	1	100.0	32					32							24
25	LTG -CLASSROOM 120	20	1	100.0	355	355											26
27	LTG - BREAKOUT - 121B	20	1	100.0	321			321									28
29	LTG - CLASSROOM - 122	20	1	100.0	451					451							30
31	LTG - STAFF 130	20	1	100.0	306	306											32
33	LTG - WOODEN SLAT CEILING	20	1	100.0	960			960									34
35	LTG - WOODEN SLAT CEILING	20	1	100.0	960					960							36

Connection/Breaker Type Legend:

BAS - Building Automation Systems	SPD - Surge Protection Device	M - Motor	LTG - Lighting
GFCI - Ground Fault Circuit Interrupter	BLO - Breaker Lock-On Device	D.F. - Demand Factor	HID - High Intensity Discharge Lighting Breaker
AFCI - Arc Fault Circuit Interrupter	R.C. - Relay Controlled	REC - Receptacle	D.C. - Direct Connection

Panel Options: Refer to Panel Notes for selected Options

				Panel Totals		Panel Parameters	
1	CSA Enclosure Rating			Estimated Load A [kVA]	4.35 kVA	Voltage	120/208 Wye
2	Feed Through			Estimated Load B [kVA]	3.59 kVA	PHASE:	3
3	Sub Feed			Estimated Load C [kVA]	4.40 kVA	WIRES:	4
4	Main Breaker			Total Est. Demand [kVA]:	12.35 kVA	MAINS [A]:	100 A
5	200% Rated Neutral Bus			Total Conn. Load [kVA]:	12.35 kVA	MAIN BREAKER [A], 1 = not required	1
6	Isolated Ground Bus					I.C. [kA]:	
7	Plug in Breaker			Estimated Current A [A]	37 A		
8	SPD			Estimated Current B [A]	30 A		
				Estimated Current C [A]	37 A		

Notes:

1) Panel Enclsoure to be Sprinklerproof.
2) Panels greater than 66 circuits shall be double tub.
3) Surge Protection Device (SPD) to be in a separate barrered enclosure with separate cover.
4) Terminate circuits for BAS in 4"x4" junction box 10' from panel.

ISSUED FOR TENDER

2026.07.08

Panel:

LP-2B

Project Name:

STERLING HALL

Project #:

00036.010.E001

Description:

Date:

Location:

ELECTRICAL 204

Fed From:

PP-2B

Smith + Andersen

CCT No.	Connection/Breaker Type - Circuit Description	BKR [A]	Pole s	DF [%]	Estimated Load [VA]	A	B	C	Estimated Load [VA]	DF [%]	Pole s	BKR [A]	Connection/Breaker Type - Circuit Description	CCT No.		
1	LTG -	20	1	100.0	90	90								2		
3	LTG - CLASSROOM 203	20	1	100.0	1416		1416							4		
5	LTG - NEAR VESTIBULE	20	1	100.0	888			888						6		
7	LTG - CLASSROOM 208 & 210	20	1	100.0	1416	1416								8		
9	LTG - STUDENT WR 207	20	1	100.0	1378		1378							10		
11	LTG - MEETING 212	20	1	100.0	608			608						12		
13	LTG - BREAKOUT 209A & 209B	20	1	100.0	709	709								14		
15	LTG - BREAKOUT 202A & 202B	20	1	100.0	677		677							16		
17														18		
19														20		
21														22		
23														24		
25														26		
27														28		
29														30		
31														32		
33														34		
35														36		
Connection/Breaker Type Legend:																
	BAS - Building Automation Systems	SPD - Surge Protection Device						M - Motor				LTG - Lighting				
	GFCI - Ground Fault Circuit Interrupter	BLO - Breaker Lock-On Device						D.F. - Demand Factor				HID - High Intensity Discharge Lighting Breaker				
	AFCI - Arc Fault Circuit Interrupter	R.C. - Relay Controlled						REC - Receptacle				D.C. - Direct Connection				
Panel Options: Refer to Panel Notes for selected Options						Panel Totals						Panel Parameters				
1	CSA Enclosure Rating					Estimated Load A [kVA]	2.22 kVA		Voltage				120/208 Wye			
2	Feed Through					Estimated Load B [kVA]	3.47 kVA		PHASE:				3			
3	Sub Feed					Estimated Load C [kVA]	1.50 kVA		WIRES:				4			
4	Main Breaker					Total Est. Demand [kVA]:	7.18 kVA		MAINS [A]:				100 A			
5	200% Rated Neutral Bus					Total Conn. Load [kVA]:	7.18 kVA		MAIN BREAKER [A], 1 = not required				1			
6	Isolated Ground Bus								I.C. [kA]:							
7	Plug in Breaker					Estimated Current A [A]	19 A									
8	SPD					Estimated Current B [A]	29 A									
						Estimated Current C [A]	13 A									
Notes:																
1) Panel Enclosure to be Sprinklerproof.																
2) Panels greater than 66 circuits shall be double tub.																
3) Surge Protection Device (SPD) to be in a separate barrered enclosure with separate cover.																
4) Terminate circuits for BAS in 4"x4" junction box 10' from panel.																

ISSUED FOR TENDER

2026.07.08

Panel:

RP-0A

Project Name:

STERLING HALL

Project #:

00036.010.E001

Description:

Date:

Location:

ELEC. CLOSET 003

Fed From:

Smith + Andersen

CCT No.	Connection/Breaker Type - Circuit Description	BKR [A]	Pole s	DF [%]	Estimated Load [VA]	A		B		C		Estimated Load [VA]	DF [%]	Pole s	BKR [A]	Connection/Breaker Type - Circuit Description	CCT No.																
1	REC - ELEC CLOSET 003	15	1	100.0	300	300	750					750	100.0	1	15	REC - SECURE STORAGE 007	2																
3	REC - MAKER SPACE 001	15	1	100.0	750			750	400			400	100.0	1	20	REC - 3D PRINTER	4																
5	D.C - FCU-LL-C003	15	2	100.0	504					252	1800	1800	100.0	1	20	REC - LAMINATOR	6																
7						252	1050					1050	100.0	1	15	REC - FLEXIBLE SPACE 002	8																
9	D.C - FCU-LL-001	15	2	100.0	504			252	150			150	100.0	1	15	REC - AV PROJECTOR	10																
11										252	900	900	100.0	1	20	REC - CORRIDOR C000	12																
13	D.C - FCU-LL-002	15	2	100.0	504	252	600					600	100.0	1	15	REC - GFCI SPACES	14																
15								252	450			450	100.0	1	15	REC - ELEV ROOM	16																
17	DC (70%)	150	3	100.0	36000					12000	150	150	100.0	1	20	REC -	18																
19						12000											20																
21								12000									22																
23	D.C - P-DHWR-1	15	1	100.0	150					150							24																
25	D.C. - P-SAN-01	15	2	100.0	380	190											26																
27								190									28																
29	D.C. - P-SAN-02	15	2	100.0	380					190							30																
31						190											32																
33	REC - AV PROJECTOR	15	1	100.0	600			600									34																
35	REC -LCD DISPLAY	15	1	100.0	150					150							36																
Connection/Breaker Type Legend:																																	
	BAS - Building Automation Systems	SPD - Surge Protection Device						M - Motor						LTG - Lighting																			
	GFCI - Ground Fault Circuit Interrupter	BLO - Breaker Lock-On Device						D.F. - Demand Factor						HID - High Intensity Discharge Lighting Breaker																			
	AFCI - Arc Fault Circuit Interrupter	R.C. - Relay Controlled						REC - Receptacle						D.C. - Direct Connection																			
Panel Options: Refer to Panel Notes for selected Options						Panel Totals						Panel Parameters																					
1	CSA Enclosure Rating					Estimated Load A [kVA]		15.58 kVA		Voltage		120/208 Wye																					
2	Feed Through					Estimated Load B [kVA]		15.04 kVA		PHASE:		3																					
3	Sub Feed					Estimated Load C [kVA]		15.84 kVA		WIRES:		4																					
4	Main Breaker					Total Est. Demand [kVA]:		46.47 kVA		MAINS [A]:		100 A																					
5	200% Rated Neutral Bus					Total Conn. Load [kVA]:		46.47 kVA		MAIN BREAKER [A], 1 = not required		1																					
6	Isolated Ground Bus									I.C. [kA]:																							
7	Plug in Breaker					Estimated Current A [A]		131 A																									
8	SPD					Estimated Current B [A]		126 A																									
						Estimated Current C [A]		133 A																									
Notes:																																	
1) Panel Enclsoure to be Sprinklerproof.																																	
2) Panels greater than 66 circuits shall be double tub.																																	
3) Surge Protection Device (SPD) to be in a separate barrered enclosure with separate cover.																																	
4) Terminate circuits for BAS in 4"x4" junction box 10' from panel.																																	

ISSUED FOR TENDER

2026.07.08

Panel:

RP-1C

Project Name:

STERLING HALL

Project #:

00036.010.E001

Description:

Date:

Location:

ELECTRICAL 204

Fed From:

Smith + Andersen

CCT No.	Connection/Breaker Type - Circuit Description	BKR [A]	Pole s	DF [%]	Estimated Load [VA]	A		B		C		Estimated Load [VA]	DF [%]	Pole s	BKR [A]	Connection/Breaker Type - Circuit Description	CCT No.
1	REC - IT/STORAGE 123	15	1	100.0	1050	1050	252					504	100.0	2	15	D.C - FCU-L1-122	2
3	REC - DATA & SECURITY RACK - IT/STORAGE 123	15	1	100.0	1050			1050	252								4
5	DC - ELECRICAL BASEBOARD HEATER	15	2	100.0	85					43	252	504	100.0	2	15	D.C - FCU-L1-121	6
7						43	252										8
9	D.C - FCU-C102-1	15	2	100.0	504			252	252			504	100.0	2	15	D.C - FCU-L1-120	10
11									252	252							
13	D.C - FCU-L1-111	15	2	100.0	504	252	252					504	100.0	2	15	D.C - FCU-L1-C120-1	14
15								252	252								
17	D.C - FCU-L1-C101	15	2	100.0	504					252	252	504	100.0	2	15	D.C - FCU-L1-C120-2	18
19						252	252										20
21	D.C - FCU-L1-103	15	2	100.0	504			252	252			504	100.0	2	15	D.C - FCU-L1-C120-3	22
23										252	252						
25	D.C - FCU-MEZZ-130	15	2	100.0	504	252	252					504	100.0	2	15	D.C - FCU-L1-127	26
27								252	252								
29	D.C - FCU-L1-101-2	15	2	100.0	1232					616	252	504	100.0	2	15	D.C - FCU-L1-128	30
31						616	252										32
33	D.C - FCU-L1-101-1	15	2	100.0	1232			616	252			504	100.0	2	15	D.C - FCU-L1-129	34
35										616	252						
37	D.C - FCU-L1-102	15	2	100.0	504	252	500					500	100.0	1	15	D.C - ERV-1	38
39								252	750			750	100.0	1	15	REC - PRAYER & OFFICE	40
41	FFH-L1-126	15	1	100.0	50					50	750	750	100.0	1	15	REC - OFFICE 111	42
43	REC - GFCI WR 104	15	1	100.0	450	450	1200					1200	100.0	1	15	REC - CLASSROOM 127	44
45	REC - PRINTER	15	1	100.0	150			150	750			750	100.0	1	15	REC - BREAKOUT 128B	46
47	REC - COFFEE MACHINE	15	1	100.0	150					150	1200	1200	100.0	1	15	REC - CLASSROOM 129	48
49	REC - MEETING 103	15	1	100.0	750	750	900					900	100.0	1	15	REC - CLASSROOM 120	50
51	REC -	15	1	100.0	750			750	900			900	100.0	1	15	REC - BREAKOUT 121A	52
53	REC -	20	1	100.0	600					600	1200	1200	100.0	1	15	REC - CLASSROOM 122	54
Connection/Breaker Type Legend:																	
	BAS - Building Automation Systems		SPD - Surge Protection Device				M - Motor				LTG - Lighting						
	GFCI - Ground Fault Circuit Interrupter		BLO - Breaker Lock-On Device				D.F. - Demand Factor				HID - High Intensity Discharge Lighting Breaker						
	AFCI - Arc Fault Circuit Interrupter		R.C. - Relay Controlled				REC - Receptacle				D.C. - Direct Connection						
Panel Options: Refer to Panel Notes for selected Options						Panel Totals						Panel Parameters					
1	CSA Enclosure Rating					Estimated Load A [kVA]		8.03 kVA		Voltage		120/208 Wye					
2	Feed Through					Estimated Load B [kVA]		7.74 kVA		PHASE:		3					
3	Sub Feed					Estimated Load C [kVA]		7.49 kVA		WIRES:		4					
4	Main Breaker					Total Est. Demand [kVA]:		23.25 kVA		MAINS [A]:		100 A					
5	200% Rated Neutral Bus					Total Conn. Load [kVA]:		23.25 kVA		MAIN BREAKER [A], 1 = not required		1					
6	Isolated Ground Bus									I.C. [kA]:							
7	Plug in Breaker					Estimated Current A [A]		67 A									
8	SPD					Estimated Current B [A]		65 A									
						Estimated Current C [A]		63 A									
Notes:																	
1) Panel Enclsoure to be Sprinklerproof.																	
2) Panels greater than 66 circuits shall be double tub.																	
3) Surge Protection Device (SPD) to be in a separate barrered enclosure with separate cover.																	
4) Terminate circuits for BAS in 4"x4" junction box 10' from panel.																	

ISSUED FOR TENDER

2026.07.08

1 General

1.1 **SECTION INCLUDES**

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

1.2 **REFERENCES**

- .1 ASTM D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
- .2 ASTM D4253, Test Method for Maximum Index Density and Unit Weight of Soil Using a Vibratory Table.
- .3 CSPI, Corrugated Steel Pipe Institute.
- .4 OPSS, Ontario Provincial Standard Specification.
- .5 CAN/ULC S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.

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 of insulation boards, vibration isolator, filter fabric and other specified non-granular items.
 - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
 - .1 Submit shop drawings in accordance with Section 01 10 10 indicating:
 - .1 Adjacent construction, elevations, sections and details, dimensions, and relationship to adjacent construction.
 - .2 Include design calculations, design concept, construction method, sequence and means by which existing structures, utilities and equipment will be protected; Location of in-use, maintained, re-routed and abandoned underground lines.
- .3 Reports:
 - .1 Submit written laboratory test reports.
 - .2 Submit written field inspection and test report results after each inspection.
- .4 Submit dewatering methods 30 days in advance for review by Consultant. If well point system is required, Engineer shall design system and supervise installation.

- .5 Submit to Consultant details of locations where surplus soils and other materials are to be disposed of or reused. Include each disposal/reuse Site and type of surplus soil or other material, location of the disposal/reuse Site, operator's name and business address, type of license under which Site operates, and criteria used by Site to access suitability of surplus material for disposal.
- .6 Submit to Consultant, within 48 hours of a load of surplus soil or other material leaving the Site, a daily register recording the time and place of disposal/reuse of each load signed by a representative of the disposal site. Such documentation must be submitted before payment for excavation will be made.

1.4 **QUALITY ASSURANCE**

- .1 Have shop drawings signed and sealed by a Professional Engineer licensed in Province of Ontario and having experience in design and inspection of shoring, bracing, underpinning and dewatering (if required) required to complete Work.
- .2 Manage on-Site and excess soil in accordance with authorities having jurisdiction.

1.5 **SITE CONDITIONS**

- .1 Geotechnical conditions: For information on subsurface conditions and soil characterizations refer to document appended to Section 00 31 00.
- .2 Cultural heritage resources: If Cultural Heritage Resources (such as archaeological sites, artifacts, building and structural remains, and/or human burials) are encountered during performance of Work, contact Consultant immediately and suspend Work in immediate area until assessment has been completed by Ministry of Culture, Tourism and Recreation. Perform required measures to mitigate negative impacts on found resources to acceptance of Consultant.

1.6 **PROTECTION**

- .1 Existing buried utilities and structures:
 - .1 Size, depth and location of known existing utilities and structures are indicated for guidance only. Completeness and accuracy is not guaranteed.
 - .2 Prior to commencing any excavation Work, have authorities stake out utility locations to prevent disturbance during Work.
 - .3 Confirm locations of buried utilities by careful test excavations. Hand dig test excavations as necessary.
 - .4 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered. Obtain permission of Consultant before moving or otherwise disturbing utilities or structures.
- .2 Existing buildings and surface features:
 - .1 Conduct with Consultant, a condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks and paving, survey bench marks and monuments which may be affected by Work.

-
- .2 Protect existing buildings and surface features which may be affected by Work from damage while Work is in progress and repair damage resulting from Work.
 - .3 Where excavation necessitates root or branch cutting, perform Work in accordance with Authorities having Jurisdiction.
 - .4 Confirm with Consultant, condition Survey of buildings and structures undertaken by Consultant.
-
- .3 Temporarily cover local existing catch basins and maintenance holes to prevent entry of earth or debris. Ensure adequate surface drainage in affected area is maintained.
 - .4 Protect Work or work of other Contracts in progress or completed and protect existing properties, stored Products, services, utilities, trees, landscaping and natural features from damage.
 - .5 Protect excavations against flooding and damage and install and maintain appropriate warning devices during construction and during time when Work is closed down for any cause.
 - .6 Protect bottom of excavations that will support foundations, slabs, pavements etc. from frost or freezing.
 - .7 Keep access roads clear of debris and dirt resulting from Work of this Section to acceptance of Authorities having jurisdiction.
 - .8 Shoring, bracing and underpinning: Comply with local regulations, authorities having jurisdictions and requirements specified.
-
- 2 Products
-
- 2.1 **MATERIALS**
-
- .1 Select fill: Subject to approval of Consultant consisting of reusable fill excavated from Site or imported fill that is free of organic matter, rubble and material other than soil. Maximum particle size of half thickness of lift specified, moisture content at time of placing 2% maximum over its optimum moisture content and is either non plastic or has a plasticity index of 25% maximum.
 - .2 Granular A fill: Imported Granular A fill, free of organic matter and, in accordance with OPSS 1010.
 - .3 Granular B Fill: Imported Granular B fill free of organic matter and in accordance with OPSS 1010.

- .4 Engineered fill: Clean, hard, durable crushed rock or stone, free of shale, clay, organic material, recycled material or any other deleterious substance. Engineered fill shall be in accordance with OPSS 1010 Granular B Type II. Moisture content shall be within 2% of Optimum Moisture Content in accordance with ASTM D698.
- .5 Clear Stone fill: 19 mm clear stone in accordance with OPSS 1004, free of organic material.
- .6 High Performance Bedding: Angular crushed aggregate, 1 mm to 8 mm in size with maximum nominal size of 6.7 mm, minimum 90% compaction on initial placement, Washed and free of dust fractions ensuring a free draining clear aggregate: High Performance Bedding (HPB) by Dufferin Aggregates or approved alternative.
- .7 Unshrinkable fill: 0.7 MPa cement stabilized backfill conforming to requirements of CAN/CSA A23.1/A23.2-M.
- .8 Dewatering equipment: Equip submersible pumps with filters and/or screens to prevent ground loss. Maintain filters in good operating condition.

3 Execution

3.1 EXAMINATION

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

3.2 LINES AND ELEVATIONS

- .1 Establish lines and elevations from Control Points shown on Contract Drawings.
- .2 Have lines and elevations established by Registered Ontario Land Surveyor or qualified Civil Engineer registered in Province of Ontario.
- .3 Protect and maintain Control Points and Bench Marks as long as they are required.

3.3 STRIPPING

- .1 Do not handle topsoil while in wet or frozen condition or in manner in which soil composition is adversely affected.
- .2 Strip topsoil from working area in locations shown.
- .3 Strip topsoil to depths indicated. Avoid mixing topsoil with subsoil.
- .4 Stockpile topsoil in locations directed by Consultant. Stockpile to height not exceeding 2 m. Remove excess topsoil from Site.

3.4 REMOVAL OF WATER

- .1 Obtain letter of conditional approval from authorities having Jurisdiction to dispose of ground water into sewer drainage system. Apply for and pay for water disposal permit.
- .2 Keep excavations and trenches free of water throughout construction period.
- .3 Groundwater removal:
 - .1 Lower groundwater level and maintain at depth below lowest point of excavation to ensure a dry stable surface.
 - .2 Dewater to prevent loss of soil and maintain stability of sides and bottom of excavation and of adjacent structures.
 - .3 Dispose of water in conformance with applicable by-laws and in a manner not detrimental to public and private property, or portion of Work completed or under construction.
 - .4 Supply and install flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to sewers, water courses or drainage areas in accordance with authorities having jurisdiction. Perform testing on settlement tank discharge to confirm that effluent meets sewer bylaw requirements. Locate tanks to acceptable area determined by Consultant.
 - .5 Should method of dewatering fail to achieve conditions specified above, Consultant reserves right to revise methods and procedures at no cost to Owner.
- .4 Surface water removal:
 - .1 Remove surface run-off in a manner that will prevent loss of soil and maintain stability of sides and bottom of excavation. Obtain Consultant's approval of dewatering method to be used.
 - .2 Discharge surface water into existing storm drainage system to acceptance of Consultant and local authorities.
- .5 Do not obstruct flow of surface drainage or natural water courses.

3.5 EXCAVATION

- .1 Remove concrete, masonry, paving, demolished foundations and rubble and other obstructions encountered during excavation Work.
- .2 Do not disturb soil within drip line of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw in a manner acceptable to authorities having jurisdiction.
- .3 Excavate to required lines and grades shown on Contract Drawings with allowance for subsequent Work including shoring, bracing and formwork. Make excavation clean and clear of loose material and true to size.

- .4 Protect stockpiles of fill against contamination and moisture absorption.
- .5 Do not undermine adjacent structures. Where it is necessary to have footings at different levels, found upper footing below imaginary 10-horizontal-to-7 vertical line, or as otherwise indicated, drawn up from base of lower footing. Protect adjacent foundations from frost.
- .6 Have excavations in excess of 1200 mm in depth conform to requirements of Occupational Health and Safety Act, and Regulations for Construction Projects.
- .7 Do not expose shale at subgrade elevation to drying cycles and in any case, following inspection, cover with minimum 50 mm of lean concrete within 4 hours after exposure.
- .8 Fill excavations for foundations which are, through error, carried below elevation shown or approved depth, with 15 MPa concrete, or as directed by Consultant.
- .9 Trim, and remove loose material, debris and organic material from excavations. Where material at bottom of excavation is disturbed, remove disturbed material and re-compact to density equal to or better than undisturbed soil or backfill with lean concrete as directed by Consultant.
- .10 When excavations are complete, prior to commencement of subsequent Work, request Consultant for inspection of excavation Work.

3.6 TRENCHING

- .1 Excavate trenches to lines and grades indicated and to a depth of 75 mm minimum below invert elevation and slope established for pipe, and backfill to invert elevation of pipe with specified granular material.
- .2 Unless otherwise authorized by Consultant, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation. Remove unsuitable material from trench bottom to extent and depth as directed by Consultant.
- .3 Backfill Over-excavation with granular material and compact.
- .4 If unstable soil conditions are encountered, excavate trenches to depth directed by Consultant and backfill to correct elevation with backfill material.
- .5 Remove loose material from bottom of trenches to ensure granular material is placed against undisturbed soil.
- .6 Compact bedding and grade as required for even and uniform support on each length of pipe.

- .7 Where excavating is required adjacent to and parallel with and below any footing, submit excavation and backfill procedures to Consultant for review prior to start of excavating.
- .8 Keep width of trenches to a minimum to ensure minimum span for pipe to be supported.
- .9 Make excavations for fire hydrants of sufficient size and depth to accommodate a minimum 0.75 m³ of crushed stone. Hand place stone and tamp around and below hydrant elbow to ensure proper drainage of hydrant.

3.7 **EXCAVATED MATERIAL DISPOSAL**

- .1 Except for material to be used as select fill, immediately remove and dispose of excavated material from Site.
- .2 Remove and dispose of construction rubble, abandoned gas, water and sewer pipes, valves, valve boxes and fittings, maintenance holes, frames and covers and other material which may be encountered during excavation but not indicated on Contract Drawings.

3.8 **ENGINEERED FILL**

- .1 Provide engineered fill below foundations in accordance with recommendations contained in the geotechnical report. The engineered fill at footing level must extend horizontally 1.2 m beyond edge of footings beyond which point the sides of the engineered fill zone may be sloped at 1 vertical to 1 horizontal.
- .2 Place engineered fill in layers not exceeding 200 mm in the uncompacted state. Compact each layer to a minimum of 100% Standard Proctor Density in accordance with Section ASTM D698.
- .3 Use mechanical compaction equipment that is appropriate for the material being placed.
- .4 Provide a minimum of 24 hours notice to the inspection and testing company to arrange for compaction testing for each layer of fill.
- .5 Do not place next lift of fill until previous lift has been tested and found to be adequately compacted in accordance with the specified level of compaction.
- .6 Confirm elevations of top of engineered fill layer upon completion of placement and compaction.
- .7 Protect surface of engineered fill from any disturbance.
- .8 Do not place fill during period of freezing ambient temperature.

- .9 Remove and replace fill until compaction test reports by the testing agency are satisfactory to the Consultant.

3.9 BACKFILLING

- .1 Do not proceed with backfilling operations until walls, slabs, waterproofing and below grade Work has been inspected and accepted by Consultant.
- .2 Backfill areas which are free from debris, snow, ice, water and frozen ground.
- .3 Do not use backfill material which is frozen or contains ice, snow or debris.
- .4 Do not backfill on or against any membrane or protection board covered waterproofing with jagged rock or other sharp objects which might damage waterproofing.
- .5 Limit vertical drop of backfill material to 2000 mm.
- .6 To avoid pockets and voids, remove sheathing and shoring materials that require removal, as backfilling progresses.
- .7 Prior to backfilling or placing concrete on exposed soil subgrade, proof roll subgrade to identify soft or loose areas. Proceed with placing backfill or concrete only after inconsistencies identified by above procedure have been reworked and compacted or excavated, backfilled and compacted as required to eliminate such conditions to acceptance of Consultant.
- .8 Place backfill material, grade and compact to levels shown on Contract Drawings.
- .9 Place backfill materials in uniform layers 200 mm maximum loose thickness unless specified otherwise.
- .10 Ensure each layer is compacted, and accepted by Consultant, before placing succeeding layers.
- .11 Unless otherwise indicated, use specified granular material from bottom of trench to 300 mm above top of pipe or 150 mm above top of electrical conduits. Hand place in 150 mm layers and compact carefully to ensure proper backfilling and compaction around bottom quadrants and sides of pipe.
- .12 For backfill from 300 mm above top of pipe or 150 mm above electrical conduits to sub-grade level, use select fill unless otherwise noted. Compact either by hand or by machine.
- .13 Do not backfill trenches until piping, conduits and cables therein have been inspected, tested, and approved by inspection authorities having jurisdiction and Consultant.

- .14 Prior to backfilling of trenches, remove wood block or wedges used to prevent movement of piping during tests.
- .15 Where there is a common boundary between select fill and granular fill or unshrinkable fill, place select fill after granular fill has been compacted. Place and compact fill around free standing structures evenly on all sides of structure simultaneously in layers sloping away from structure.
- .16 During backfilling, take care to avoid displacing or damaging Utilities Work and Services.
- .17 Notify Consultant prior to commencement of backfilling and compacting operations.

3.10 **COMPACTION**

- .1 Compaction densities for select fill, granular fill, and sand fill materials will be determined by ASTM D698. Compaction densities for clear stone and pea gravel will be determined by ASTM D4253.
- .2 Add water if necessary to obtain required densities. Correct irregularities or depressions that may develop during compaction by removing or adding material to form a smooth and uniform surface.
- .3 Shape and roll alternately to obtain smooth, even and uniformly compacted base.
- .4 If material is excessively moist, aerate by scarifying with suitable equipment until moisture content is corrected.
- .5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers acceptable to Consultant.
- .6 Compact backfill materials in accordance with Geotechnical Report providing the following as a minimum:
 - .1 Imported fill: 98% standard Proctor maximum dry density (SPMDD).
 - .2 Under slabs, walks and pavements: 100% (SPMDD).
 - .3 All other areas: 95% (SPMDD).

3.11 **GRADING**

- .1 Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.
- .2 Place material only on clean unfrozen surface, properly shaped and compacted and free from snow and ice. Ensure no frozen material is used in placing.
- .3 Grade as necessary to bring Work areas to required elevations. Supply additional material required to obtain new grade levels. Place and compact as specified.

- .4 Grade drainage ditches to elevations indicated on Contract Drawings.
- .5 Maintain positive drainage.
- .6 Grade materials using methods which do not lead to segregation or degradation of aggregate.
- .7 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
- .8 Remove and replace that portion of layer in which material becomes segregated during spreading.
- .9 Slope grade away from buildings 1:50 minimum.
- .10 Make graded areas smooth to profile, free of debris, with local excavations and depressions filled and compacted.
- .11 Do not disturb soil within branch spread of trees and shrubs remaining.
- .12 Cultivate entire area which is to receive topsoil to a depth of 100 mm. Repeat cultivation in those areas where equipment used for hauling and spreading has compacted soil.
- .13 Remove surface debris, roots, vegetation, branches and stones in excess of 50 mm in diameter.

3.12 **FINISH GRADING**

- .1 Fine grade and loosen topsoil. Eliminate rough spots and low areas to ensure positive drainage. Prepare loose friable bed by means of cultivation and subsequent raking.
- .2 Roll to consolidate topsoil for areas to be seeded or sodded leaving surface smooth, uniform, firm against deep foot printing, and with fine loose texture to approval of Consultant.

3.13 **UNSHRINKABLE FILL**

- .1 Place unshrinkable fill in locations indicated on Contract Drawings or where Work area is too limited to permit proper placing and compaction. Obtain Consultants approval prior to placing unshrinkable fill. Place in accordance with supplier's written instructions.
- .2 If embedded items occur in area being backfilled, coordinate with appropriate trades to ensure that disturbance of embedded items during backfilling is prevented.

END OF SECTION

APPENDICES
