



BROCK HIGH SCHOOL RENOVATIONS

Durham Regional Road 12, Cannington ON. L0E 1E0

Issued for Tender

Project 25233

DATE: April, 2026

BBA
BARRY BRYAN ASSOCIATES

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Designated Substance Report

23079-01 DDSB, Brock HS, HVAC Upgrades, Dsub

End of Section

Dwg. No.	Title	Issue No.	Rev. No.	Issue Date
ARCHITECTURAL				
A000	OBC Matrix, Location Plan and Drawing List	3	-	April 28, 2026
A201	Key Plans	3	-	April 28, 2026
A202	Ground & Second Floor Demolition Reflected Ceiling Plans	3	-	April 28, 2026
A203	Third Floor Demolition Plans & Reflective Ceiling Plans	3	-	April 28, 2026
A204	Third Floor Demolition Reflective Ceiling Plans	3	-	April 28, 2026
A205	Roof Plans	3	-	April 28, 2026
A206	Ground & Second Floor Proposed Reflected Ceiling Plans	3	-	April 28, 2026
A207	Third Floor Proposed Plans & Reflective Ceiling Plans	3	-	April 28, 2026
A208	Third Floor Proposed Reflective Ceiling Plans	3	-	April 28, 2026
A209	Not Used	3	-	April 28, 2026
A210	Demolition Washroom Plans & Reflected Ceiling Plans	3	-	April 28, 2026
A211	Proposed Gender Neutral Washroom and Universal Washroom Plans & Reflective Ceiling Plans	3	-	April 28, 2026
A701	Sections, Interior Elevations & Schedules	3	-	April 28, 2026
A702	Sections	3	-	April 28, 2026
STRUCTURAL				
S101	General Notes and Typical Details	2	-	April 28, 2026
S102	Key Plans	2	-	April 28, 2026
S201	Part Ground Floor Plan	2	-	April 28, 2026
S202	Part Second Floor Plan	2	-	April 28, 2026
S203	Part Third Floor Plans	2	-	April 28, 2026
S204	Part Roof Framing Plans	2	-	April 28, 2026
S205	Part Plans – Universal Washroom	2	-	April 28, 2026
S501	Sections & Details	2	-	April 28, 2026
MECHANICAL				
M100	Drawing List, Symbol List, and Key Plans	3	-	April 28, 2026
M200	North Classroom Wing Floor Plans – New Work - HVAC	3	-	April 28, 2026
M201	North Classroom Wing Floor Plans – New Work - HVAC	3	-	April 28, 2026
M202	Main Office - Floor Plans – New Work - HVAC	3	-	April 28, 2026
M203	South Classroom Wing Floor Plans – HVAC	3	-	April 28, 2026
M204	Automotive Wing Floor Plans – HVAC	3	-	April 28, 2026

Dwg. No.	Title	Issue No.	Rev. No.	Issue Date
M205	Roof Plan – Demolition – HVAC	3	-	April 28, 2026
M206	Roof Plan – New Work - HVAC	3	-	April 28, 2026
M301	Mechanical RM #3 – Enlarged Plans	3	-	April 28, 2026
M302	Mechanical RM #6 – Enlarged Plans	3	-	April 28, 2026
M303	Mechanical Rm #9 – Enlarged Plans	3	-	April 28, 2026
M401	Gender Neutral Washrooms – Demolition Plans	3	-	April 28, 2026
M402	Gender Neutral Washrooms – New Work Plans	3	-	April 28, 2026
M403	Universal Washroom – Plans	3	-	April 28, 2026
M500	Control Diagrams #1	3	-	April 28, 2026
M501	Control Diagrams #2	3	-	April 28, 2026
M502	Control Diagrams #3	3	-	April 28, 2026
M503	Control Diagrams #4	3	-	April 28, 2026
M504	Control Diagrams #5	3	-	April 28, 2026
M600	Mechanical – Typical Details #1	3	-	April 28, 2026
M601	Mechanical – Typical Details #2	3	-	April 28, 2026
M602	Mechanical – Typical Details #3	3	-	April 28, 2026
M603	Mechanical – Typical Details #4	3	-	April 28, 2026
M604	Mechanical – Typical Details #5	3	-	April 28, 2026
M610	Air Handling Unit Details #1	3	-	April 28, 2026
M700	Mechanical Schedules #1	3	-	April 28, 2026
M701	Mechanical Schedules #2	3	-	April 28, 2026
M702	Mechanical Schedules #3	3	-	April 28, 2026
ELECTRICAL				
E100	Electrical Symbols, Notes and Key Plan	2	-	April 28, 2026
E101	Electrical Specification (1)	2	-	April 28, 2026
E102	Electrical Specification (2)	2	-	April 28, 2026
E200	Electrical North Classroom Wing 1 st Floor RCP Plan	2	-	April 28, 2026
E201	Electrical North Classroom Wing 2 nd Floor RCP Plan	2	-	April 28, 2026
E202	Electrical South Classroom Wing 2 nd Floor RCP Plan	2	-	April 28, 2026
E203	Electrical Automotive Wing 2 nd Floor RCP Plan	2	-	April 28, 2026
E300	Electrical North Classroom Wing 1 st Floor PWR Plan	2	-	April 28, 2026
E301	Electrical North Classroom Wing 2 nd Floor PWR Plan	2	-	April 28, 2026
E302	Electrical South Classroom Wing 2 nd Floor PWR Plan	2	-	April 28, 2026
E303	Electrical Automotive Wing 2 nd Floor PWR Plan	2	-	April 28, 2026

Project: 25233
Description: BROCK HIGH SCHOOL RENOVATIONS

**GENERAL REQUIREMENTS
LIST OF DRAWINGS
Section 01 00 60**

Dwg. No.	Title	Issue No.	Rev. No.	Issue Date
E400	Electrical South Wing Universal Washroom Part Plan	2	-	April 28, 2026
E500	Electrical Roof Plan - Demolition	2	-	April 28, 2026
E501	Electrical Roof Plan - New	2	-	April 28, 2026
E600	Electrical Details, Panel Schedule and Single Line Diagram	2	-	April 28, 2026
E700	Electrical Fire Alarm System Riser Diagram and Details	2	-	April 28, 2026

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Work covered by contract documents
- .2 Location of the site
- .3 Site access
- .4 Contractor traffic route
- .5 Work sequence
- .6 Contractor use of premises
- .7 References and codes
- .8 Engineer design
- .9 Hazardous material discovery
- .10 Building smoking environment
- .11 Site security
- .12 Protection of Drawings
- .13 "By Others"

1.2 Work Covered by Contract Documents

- .1 Work of this Contract comprises the **Renovation, Brock High School Durham Regional Road 12, Cannington, Ontario**, for the **Durham District School Board**, and as indicated on the drawings and specifications.

1.3 Partial Owner Occupancy

- .1 Owner, or other contractors or suppliers retained by the Owner, will occupy areas of the building and site during the course of the work.
- .2 The existing **Brock High School** beyond the work area limits, will remain in use by the Owner throughout the construction period.
- .3 The Contractor will be the "Constructor" as defined by the Occupational Health and Safety Act on this project and will be solely responsible for all persons on the Site including Owner and contractors or suppliers retained by the Owner.
- .4 Work in occupied areas beyond the limits of hoarding shall be completed during non-school hours as approved and agreed with the Owner.

1.4 Owner Furnished Items

- .1 The following items will be supplied by the Owner for installation by the Contractor:
 - 1. Any items specifically mentioned in the Contract Documents.

1.5 Site Access

- .1 Access to the site to be arranged by the Owner.

1.6 Work Sequence

- .1 Construct Work continuously.

1.7 Site Reference and Documentation

- .1 Obtain from the Owner and be familiar with all available reference material and historic documentation for the building site.
- .2 Maintain a copy of all reference materials and documents on site for the duration of the Work.
- .3 No claims for extras or for delay will be considered due to the Contractor's failure to fully apprise himself of the condition of the site prior to commencement of the work.

1.8 References and Codes

- .1 Perform Work in accordance with Ontario Building Code (OBC), National Fire Code of Canada (NFC), the Canadian Electrical Code CAN C22.1, and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
- .2 Meet or exceed requirements of:
 - .1 Contract documents.
 - .2 Specified standards, codes and referenced documents.

1.9 Engineer Design

- .1 Where specifications require work to be designed by an engineer, engage an engineer licensed in the Province of Ontario to design such work.

1.10 Hazardous Material Discovery

- .1 Should hazardous materials be encountered which are not identified in the referenced reports, stop work and contact the Owner and Consultant immediately.

1.11 Building Smoking Environment

- .1 Smoking is prohibited in all workplaces within the Owner's buildings and on School Board property.

1.12 Site Security

- .1 Daily Inspection: Provide inspection of the building and site daily while the work is in progress and take whatever measures are necessary to secure the building and site from theft, vandalism and unauthorized entry.

1.13 Protection of Drawings

- .1 Copyright of electronic document belongs to the Consultant. Electronic documents may not be forwarded to others, transmitted, downloaded or reproduced in any format, whether print or electronic, without the express, written permission of the copyright owner.
- .2 Drawings, specifications and other contract related documents which are posted on Contractor controlled websites for access by sub-trades and suppliers, shall be posted only on password protected and secure websites approved by the Consultant to limit access to those with an expressed interest in the Project.
- .3 Provide Consultant and Owner with access to such websites as noted above.

1.14 "By Others"

- .1 The term "by others" where it is used in the contract documents means that work shown or described in the contract documents and labeled with this designation is not included in the specific sub-trade's scope of work but will be required to be done within the General Contractor's contract.

PART 2 PRODUCTS

2.2 Materials

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

SAMPLE

[Date]

[CONTRACTOR'S COMPANY]

ADDRESS

CITY, PROVINCE, POSTAL CODE]

Attention: [INSERT CONTACT NAME]

At your request, BBA will provide electronic files for your convenience and use in the preparation of your shop drawings for Project Name, subject to the following terms and conditions:

Our electronic files are compatible with [AutoCAD 2022 (**)]. We make no representation as to the compatibility of these files with your hardware or your software beyond the specified release of the referenced drawings.

Data contained on these electronic files are part of our instruments of service, and at all times remain the exclusive property of Barry Bryan Associates and copyright is reserved. The electronic files shall not be used by you for any purpose other than as a convenience in the preparation of shop drawings for the referenced project. You further agree not to transfer these electronic files to others without the prior written consent of Barry Bryan Associates. Any other use or reuse by you or by others will be at your sole risk and without liability or legal exposure to us. You agree to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against us, our officers, directors, employees, agents or other project consultants that may arise out of or in connection with your use of the electronic files.

Furthermore, you shall, to the fullest extent permitted by law, indemnify and hold us harmless against all damages, liabilities or costs, including reasonable attorneys' fees and defence costs, arising out of or resulting from your use of these electronic files, or from the use by others, should they have obtained them from you.

These electronic files are not construction documents. Differences may exist between these electronic files and corresponding hard-copy construction documents. We make no representation regarding the accuracy or completeness of the electronic files you receive. In the event that a conflict arises between the hard-copy construction documents prepared by us and the electronic files, the hard-copy construction documents shall govern. You are responsible for determining if any conflict exists.

Due to the nature of the design and construction process, the drawings on these electronic files may not be fully coordinated, may change, and may not incorporate revisions, change orders, or addenda. By your use of these electronic files, you are not relieved of your duty to fully comply with the contract documents, including, and without limitation, the need to check, confirm and coordinate all dimensions and details, take field measurements, verify field conditions and coordinate your work with that of other contractors for the project.

Because information presented on the electronic files can be modified, unintentionally or otherwise, we require all indications of our ownership and/or involvement be removed from each electronic display.

We will furnish you electronic files upon your written request.

Under no circumstances shall delivery of the electronic files for use by you be deemed a sale by us, and we make no warranties, either express or implied, of merchantability of fitness for any particular purpose. In no event shall we be liable for any loss of profit or any consequential damages as a result of your use or reuse of these electronic files.

Barry Bryan Associates

[CONTRACTOR FIRM NAME]

PART 1 GENERAL

1.1 Consultants

- .1 ARCHITECT:
Barry Bryan Associates
201 - 250 Water Street
Whitby, Ontario L1N 0G5
Tel: (905) 666-5252
Fax: (905) 666-5256
Attention: Ms. Cassandra Cautius, OAA
- .2 STRUCTURAL ENGINEER:
Barry Bryan Associates
201 - 250 Water Street
Whitby, Ontario L1N 0G5
Tel: (905) 666-5252
Fax: (905) 666-5256
Attention: Mr. Doug McLaughlin, P. Eng.
- .3 MECHANICAL ENGINEER:
RDZ Engineers LTD
17A-30 Pennsylvania Avenue,
Vaughan, Ontario L4K 4A5
Tel: (905)-999-3046
Attention: Mr. Michael Hughes, P.Eng.
- .4 ELECTRICAL ENGINEER:
RDZ Engineers LTD
17A-30 Pennsylvania Avenue,
Vaughan, Ontario L4K 4A5
Tel: (647) 863-0662
Attention: Mr. Fei Han, P.Eng. LEED Green Associate

PART 2 PRODUCTS

3.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.2 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Access and Egress
- .2 Use of Site and Facilities
- .3 Alterations, Additions or Repairs to Existing Buildings
- .4 Existing Services
- .5 Special Requirements
- .6 Security
- .7 Building Smoking Environment

1.2 Access and Egress

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

1.3 Use of Site and Facilities

- .1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Owner to facilitate work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access.
- .3 Where security is reduced by work provide temporary means to maintain security.
- .4 Owner will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean.
- .5 Protect walls of passenger elevators, to approval of Owner prior to use.
- .6 Accept liability for damage, safety of equipment and overloading of existing equipment.
- .7 Closures: protect work temporarily until permanent enclosures are completed.

1.4 Alterations, Additions or Repairs to Existing Buildings

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

1.5 Existing Services

- .1 Notify, Owner, utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Owner 48 hours of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.
- .3 Provide for personnel, pedestrian and vehicular traffic.
- .4 Construct barriers in accordance with Section 01 56 00.

1.6 Special Requirements

- .1 Coordinate noise generating work Monday to Friday with custodial staff on site.
- .2 Submit schedule in GANTT format.
- .3 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .4 Keep within limits of work and avenues of ingress and egress.
- .5 Deliver materials outside of peak traffic hours [17:00] to [07:00] and [13:00] to [15:00] unless otherwise approved by Owner.
- .6 Prior to cutting or drilling horizontal or vertical surfaces including concrete, concrete block or other structural substrate, determine location of reinforcing, service lines, pipes, conduits or other items by x-ray, ground penetrating radar or other appropriate method. Submit findings to Owner prior to cutting or drilling.

1.7 Security

- .1 Where security has been reduced by Work of Contract, provide temporary means to maintain security.
- .2 Security clearances:
 - .1 Personnel employed on this project will be subject to security check. Obtain clearance, as instructed, for each individual who will require to enter premises.
 - .2 Personnel will be checked daily at start of work shift and provided with pass which must be worn at all times. Each pass must be returned at end of work shift and personnel checked out.

1.8 Building Smoking Environment

- .1 Comply with smoking restrictions. Smoking and vaping is not permitted.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Cash Allowances

1.2 References

- .1 Canadian Construction Documents Committee CCDC2-2020 Stipulated Price Contract including the Supplementary Conditions.

1.3 Cash Allowances

- .1 Refer to General Conditions, GC4.1.
- .2 Unless otherwise specified, Cash Allowances shall cover the cost of the materials and equipment delivered F.O.B. job site, and all applicable taxes, except Harmonized Sales Tax. The Contractor's handling costs on the site, labour, installation costs, overhead and profit and other expenses shall be included separately in the Stipulated Price and not in the Cash Allowance.
- .3 Where it is specified that a Cash Allowances is to include both supply and installation costs, such allowances shall cover the cost of the materials and equipment delivered and unloaded at the site, all applicable taxes and the contractor's handling costs on the site, labour and installation costs and other expenses, except overhead and profit which shall be included separately in the Stipulated Price.
- .4 If the cost of the Work covered by Cash Allowances, when determined, is more or less than the allowance, the Contract Sum shall be adjusted accordingly.
- .5 In the event that the cost of the work covered by Cash Allowances should exceed the cash allowance, while the Contract Sum will be adjusted in conformity therewith, there shall be no adjustment to the Contractor's fee or other expenses such as overhead or profit, it being understood and agreed that the contract sum includes the Contractor's expenses and profit for all Cash Allowances whether or not they are exceeded.
- .6 Progress payments on accounts of work authorized under Cash Allowances shall be included in monthly certificate for payment.
- .7 Expenditures from Cash Allowances shall be authorized by Site Instruction, Change Directive or Change Order.
- .8 Cash Allowance for independent inspection and testing shall cover the cost of such services as provided by independent testing agency only. The Contractor's cost for labour, overhead and other expenses related to independent inspection and testing shall be included separately in the Stipulated Price and not in the Cash Allowance.
- .9 Cause the work covered by Cash Allowances to be performed for such amounts and by such persons as the Consultant may select and direct or as required by the project drawings and specifications.
- .10 Amount of each allowance, for Work specified in respective specification Sections is as follows:
 - .1 Inspection and Testing \$10,000.00
 - .2 Miscellaneous \$90,000.00

PART 2 PRODUCTS

2.1 Not Used

.1 Not used

PART 3 EXECUTION

3.1 Not Used

.1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Requests for Substitution (RFS) prior to execution of Contract.
- .2 Requests for Substitution (RFS) after execution of Contract.

1.2 Definitions

- .1 Products Not Available: When all listed manufacturers products in the specification section are no longer manufactured.
- .2 Proprietary Specification: a specification which includes one or more proprietary names of products or manufacturers, or both, and may also include descriptive, reference standard, or performance requirements, or any combination thereof.
- .3 Non-proprietary Specification: a specification which includes descriptive, reference standard or performance requirements, or any combination thereof, but does not include proprietary names of products or manufacturers.
- .4 Substitution: a product or manufacturer not specified by proprietary name, which may be acceptable in place of a product or manufacturer which, is specified by proprietary name.

1.3 Procedures

- .1 Product Options:
 - .1 For products specified by non-proprietary specification:
 - .1 Select any product by any manufacturer, which meets requirements of Contract Documents.
 - .2 For products specified by proprietary specification:
 - .1 Select any product or manufacturer named, or
 - .2 Substitute an unnamed product or manufacturer in accordance with Substitutions – Manufacturers article of this Section.
 - .3 For products specified by proprietary specification and accompanied by words indicating that substitutions will not be accepted:
 - .1 Select any product or manufacturer named; substitutions are not permitted.
- .2 Substitution Requests Prior to Execution of Contract: Submit substitutions requests to Consultant no later than the time stated in the Instructions to Bidders.

1.4 Substitutions – Products

- .1 Substitute Products: Where substitute products are permitted, unnamed products may be accepted by the Consultant, subject to the following:
 - .1 Substitute products shall be the same type as, be capable of performing the same functions as, and meet or exceed the standards of quality and performance of the specified products.
 - .2 Substitutions for Cause: Changes proposed by Subcontractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - .3 Substitutions for Convenience: Changes proposed by Subcontractor or Contractor that are not required in order to meet other Project requirements but may offer advantage to Contractor or Subcontractor.

1.5 Substitutions – Manufacturers

- .1 Substitute Manufacturers: Where substitute manufacturers are permitted, unnamed manufacturers will be accepted by the Consultant, subject to the following:
 - .1 Substitute manufacturers shall have capabilities comparable to those of the named manufacturers.
 - .2 In making a substitution Contractor and the Subcontractor represents that they have:
 - .1 Investigated substitute product or manufacturer, or both, and determined it meets or exceeds the criteria of the specified product, and;
 - .2 Will provide the same warranty for the Substitution as for the specified product.
 - .3 Will make any changes to the Work necessitated by substitution as required for Work to be complete in all respects, and;
 - .4 Waives claims for additional costs and time caused by substitution which may subsequently become apparent.
 - .5 Will reimburse Consultant's services for review or redesign, additional studies, investigations, review of submittals, and associated contract administration.
 - .6 Received necessary approvals of authorities having jurisdiction.
 - .7 Investigated the proposed substitute to determine if license fees and royalties are pending.
 - .8 If accepted, the substitution will not adversely affect the Construction Schedule.
 - .3 Do not install requested Substitutions without Consultant's acceptance.
 - .4 If, in the Consultant's opinion, a substitution does not meet requirements of Contract Documents, Contractor shall, at no extra cost to Owner, provide a product which, in the Consultant's opinion, does meet requirements of Contract Documents.

1.6 Proprietary Specifications

- .1 Notwithstanding specified proprietary names of either or both products or manufacturers, products provided shall meet other applicable requirements of Contract Documents. Modify products if necessary, to ensure compliance with all requirements of Contract Documents.

1.7 Changes to Accepted Products and Manufacturers

- .1 Products and manufacturers accepted by the Consultant for use in performance of Work of Contract shall not be changed without Consultant's written consent. .
- .2 Submit requests to change accepted products and manufacturers to Consultant in writing, including product data indicated in Product Data article.

1.8 Product Data

- .1 When requested by the Consultant, submit complete data substantiating compliance of a product with requirements of Contract Documents. Include the following:
 - .1 Product identification, including manufacturer's name and address.
 - .2 Manufacturer's literature providing product descriptions, applicable reference standards, performance and test data, in form consistent with the Contract Documents and readily comparable with product being substituted and can provide the specified and indicated requirements.
 - .3 Samples, as applicable.
 - .4 Name and address of projects on which product has been used and date of each installation.
 - .5 Itemized comparison of substitution with named product(s). List significant variations.
 - .6 Designation of availability of maintenance services and sources of replacement materials
 - .7 Completed Substitutions Request Form. Incomplete forms will be rejected.

1.9 Consultant Procedure

- .1 In reviewing the supporting data submitted for substitutions, Consultant will use, for purposes of comparison, all the characteristics of the specified material or equipment as they appear in the manufacturer's published data even though all the characteristics may not have been particularly mentioned in the Specifications.
- .2 Consultant will review supporting data and will determine that the substitution in the Consultant's opinion is or is not able to meet or exceed the standards of quality, appearance and performance to the material specified.
- .3 Consultant will sign, date and issue the RFS indicating acceptance or refusal, with applicable pre-contract or contract documentation, to affected participants.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 01 31 00 Project Management and Coordination
- .2 Section 01 33 00 Submittal Procedures

1.3 Request for Information (RFI)

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

1.4 Submittal Procedures

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Number RFI's consecutively in one sequence in order submitted, in numbering system as established by the Contractor.
- .2 Submit one distinct subject per RFI form. Do not combine unrelated items on one form.
- .3 RFI form:
 - .1 Submit RFI's to the Consultant on "Request for Information" form. 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 thereon, attach additional sheets as required.
 - .3 Submit with RFI form all necessary supporting documentation.
- .4 RFI log:
 - .1 Maintain log of RFI's sent to and responses received from the Consultant, complete with corresponding dates.
 - .2 Submit updated log of RFI's at each construction meeting and with each application for payment submission.
- .5 Submit RFI's 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 RFI's to the Consultant.
- .7 RFI's submitted by Subcontractors or Suppliers directly to the Consultant shall not be accepted.

1.5 Screening of RFI's

- .1 Contractor shall satisfy itself 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. 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.

1.6 Response to RFI's

- .1 Consultant shall review RFI's 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 RFI's. Responses to RFI's received from entities other than the Consultant shall not be considered.

1.7 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 RFI's or the Consultant considers the RFI to be of such complexity that the Consultant cannot process these RFI's 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 RFI's, 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 RFI's 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.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Preconstruction Conference

- .1 The Consultant will call for and administer Preconstruction Conference at time and place to be announced.
- .2 Contractor, all major Subcontractors, and major suppliers shall attend the Preconstruction Conference.
- .3 Agenda will include, but not be limited to, the following items.
 - .1 Lines of communication and contact information
 - .2 Schedules
 - .3 Personnel and vehicle permit procedures
 - .4 Use of premises
 - .5 Location of any Contractor on-Site facilities
 - .6 Security
 - .7 Housekeeping
 - .8 Submittal and RFI procedures
 - .9 Inspection and testing procedures, on-Site and off-Site
 - .10 Control and reference point survey procedures
 - .11 Injury and Illness Prevention Program
 - .12 Contractor's Schedule of Values if applicable.
 - .13 Contractor's Schedule of Submittals
- .4 The Consultant will distribute copies of minutes to attendees. Attendees shall have seven (7) days to submit comments or additions to minutes. Minutes will constitute final documentation of results of Preconstruction Conference.

1.3 Project Meetings

- .1 The Contractor will arrange project meetings and assume responsibility for setting times and recording and distributing minutes.
- .2 Project meetings shall be held bi-weekly.
- .3 Meeting minutes shall be distributed to all parties within three days of the meeting.
- .4 Attendees at project meetings shall include as a minimum; Owner, Consultant, Contractors Project manager and Site Superintendent and major subcontractors.

1.4 Safety Meetings

- .1 Conduct monthly contractor safety committee meetings.
- .2 Conduct weekly toolbox talks.

1.5 On-Site Documents

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

- .1 Contract drawings.
- .2 Specifications.
- .3 Addenda.
- .4 Reviewed shop drawings.
- .5 Requests for Information (RFI's)
- .6 Change orders.
- .7 Other modifications to Contract.
- .8 Field test reports.
- .9 Copy of approved Work schedule.
- .10 Manufacturers' installation and application instructions.
- .11 Health and Safety Plan and Other Safety Related Documents.
- .12 Designated substances reports.
- .13 Other documents as specified.

1.6 Schedules

- .1 Submit a construction progress schedule to Consultant within 10 working days of the Contract award and at least 10 working days prior to the submission of the first progress claim. The construction progress schedule must show anticipated progress stages and final completion of the work within the time periods required by the Contract documents.
- .2 During progress of Work revise and resubmit as directed by Consultant.

1.7 Requests for Information (RFI's)

- .1 Refer to Section 01 26 15 – Requests for Information

1.8 Closeout Procedure

- .1 Notify Consultant when Work is considered ready for Substantial Performance.
- .2 Accompany Consultant on preliminary inspection to determine items listed for completion or correction.
- .3 Comply with Consultant's instructions for correction of items of Work listed in executed certificate of Substantial Performance.
- .4 Notify Consultant of instructions for completion of items of Work determined in Consultant's final inspection.

1.9 Cost Breakdown

- .1 Submit a detailed cost breakdown to Consultant at least ten (10) working days prior to the submission of the first progress claim. After approval by Consultant the cost breakdown will be used as basis for progress payment.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

.1 Not used

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 01 33 00 Submittal Procedures
- .2 Section 01 77 00 Closeout Procedures

1.3 Submittals

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

1.4 Schedules Required

- .1 Submit schedules as follows:
 - .1 Construction Progress Schedule.
 - .2 Submittal Schedule for Shop Drawings and Product Data.
 - .3 Submittal Schedule for Samples.
 - .4 Product Delivery Schedule.
 - .5 Cash Allowance Schedule for purchasing Products.
 - .6 Shutdown or closure activity.

1.5 Format

- .1 Prepare schedule in form of a horizontal bar chart using MS Project spreadsheets.
- .2 Provide a separate bar for each major item of work, trade or operation.
- .3 Split horizontally for projected and actual performance.
- .4 Provide horizontal time scale identifying first work day of each week.
- .5 Format for listings: chronological order of start of each item of work.
- .6 Identification of listings: By Systems description.
- .7 Maintain schedule up to date.

1.6 Submission

- .1 Submit schedules in electronic format, forward on disc as PDF files.
- .2 Submit one opaque reproduction, plus 2 copies to be retained by Consultant.
- .3 Consultant will review schedule and return review copy within 10 days after receipt.
- .4 Following Consultants review, and prior to commencement of the Work, the schedule shall be reviewed jointly, by the Owner, Consultant and Contractor and approved by all parties.
- .5 Resubmit finalized schedule within 7 days after return of review copy.

- .6 No changes are to be made to the agreed upon construction schedule without prior approval by all parties (owner, architect & contractor) through a signed change order.
- .7 Submit revised progress schedule at each regularly scheduled project meeting and with each application for payment.
- .8 Indicate any changes in completion dates in relation to the original Contract dates.
- .9 Distribute copies of revised schedule to:
 - .1 Job site office.
 - .2 Subcontractors.
 - .3 Other concerned parties.
 - .4 Instruct recipients to report to Contractor within 10 days, any problems anticipated by timetable shown in schedule.

1.7 Critical Path Scheduling

- .1 Include complete sequence of construction activities.
- .2 Include dates for commencement and completion of each element of construction.
- .3 Show projected percentage of completion of each item as of first day of month.
- .4 Indicate progress of each activity to date of submission schedule.
- .5 Show changes occurring since previous submission of schedule:
 - .1 Major changes in scope.
 - .2 Activities modified since previous submission.
 - .3 Revised projections of progress and completion.
 - .4 Other identifiable changes.
- .6 Provide a narrative report to define:
 - .1 Problem areas, anticipated delays, and impact on schedule.
 - .2 Corrective action recommended and its effect.
 - .3 Effect of changes on schedules of other prime contractors.

1.8 Submittals Schedule

- .1 Include schedule for submitting shop drawings, product data, and samples.
- .2 Indicate dates for submitting, review time, resubmission time, last date for meeting fabrication schedule.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

.1 Not used

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Section Includes

- .1 Shop drawings and product data.
- .2 Samples.
- .3 Certificates and transcripts.

1.3 Related Sections

- .1 Section 01 26 15 Requests for Information
- .2 Section 01 31 00 Project Management and Coordination

1.4 Administrative

- .1 Submit to Consultant submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Work affected by submittal shall not proceed until review is complete.
- .3 Present shop drawings, product data, samples and mock-ups in metric units.
- .4 Review submittals prior to submission to Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .5 Notify Consultant in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .6 Verify field measurements and affected adjacent work are coordinated.
- .7 Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's review.
- .8 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Consultant's review.
- .9 Keep one reviewed copy of each submission on site.

1.5 Requests for Information (RFI's)

- .1 Refer to Section 01 26 15 – Requests for Information

1.6 Shop Drawings and Product Data

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided to illustrate details of a portion of Work.
- .2 Coordinate each submission with requirements of work and Contract Documents. Individual submissions will not be reviewed until all related information is available.
- .3 Submit shop drawings bearing stamp and signature of qualified professional Engineer registered or licensed in the Province of Ontario where required by the individual specification sections. Each submittal and each resubmittal must bear the stamp of the Engineer.
- .4 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .5 Allow ten (10) days for Consultant's review of each submission.
- .6 Adjustments made on shop drawings by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.
- .7 Make changes in shop drawings as Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant in writing of revisions other than those requested.
- .8 Accompany submissions with transmittal letter containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Other pertinent data.
- .9 Submissions shall include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.
 - .5 Performance characteristics.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.
 - .10 Relationship to adjacent work.

- .10 After Consultant's review, distribute copies.
- .11 Submit 3 prints plus one electronic copy in PDF format of shop drawings for each requirement requested in specification Sections and as Consultant may reasonably request.
- .12 Submit electronic copy in PDF format of product data sheets or brochures for requirements requested in Specification Sections and as requested by Consultant where shop drawings will not be prepared due to standardized manufacture of product.
- .13 Delete information not applicable to project.
- .14 Supplement standard information to provide details applicable to project.
- .15 If upon review by Consultant, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
- .16 The review of shop drawings by the Consultant is for sole purpose of ascertaining conformance with general concept.
 - .1 This review shall not mean that the Consultant approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
 - .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.7 Interference Drawings

- .1 Prepare interference drawings to coordinate the installation of the work of all sections, within available space. Conflicts between trades which could be determined beforehand, by the careful coordination and preparation of interference drawings, shall be corrected at no expense to the Owner.
- .2 The Contractor is responsible to have reviewed the drawings prior to submission of his bid and confirms that all equipment can be installed as proposed in the drawings. No additional costs will be accepted for failure to complete this review.
- .3 Prepare interference drawings of all buried services as necessary to avoid conflicts with new or existing structures, foundations or services.
- .4 Submit interference and equipment placing drawings as specified in Section 01 71 00, when requested by the Consultant.

1.8 Progress Photographs

- .1 Progress photograph to be electronically formatted and labelled as to location and view.

1.9 Samples

- .1 Submit for review samples as requested in respective specification Sections. Label samples with origin, manufacturer, product information, applicable specification section, and intended use.

- .2 Notify Consultant in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .3 Where colour, pattern or texture is criterion, submit full range of manufacturer's samples.
- .4 Adjustments made on samples by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.
- .5 Make changes in samples which Consultant may require, consistent with Contract Documents.
- .6 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.10 Mock-Ups

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

1.11 Certificates and Transcripts

- .1 Submit Workers' Compensation Board status.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 01 41 00 Regulatory Requirements
- .2 Section 01 51 00 Temporary Utilities
- .3 Section 01 56 00 Temporary Barriers and Enclosures

1.3 References

- .1 Statutes of Canada 1999 Chapter 33. Canadian Environmental Protection Act 1999.
 - .1 SOR/2003-289. Federal Halocarbon Regulations, 2003.
 - .2 Transportation of Dangerous Goods Act, 1992 (1992, c. 34)

1.4 Administrative

- .1 Comply with all federal, provincial, and municipal regulatory requirements and guidelines for environmental protection and natural resource conservation, including those referenced above.
- .2 The Work Site is subject to inspection by the Consultant, without prior notice.
- .3 Failure to comply with environmental requirements may result in a stop work order or assessment of damages commensurate with repair of damage.
- .4 It is the Contractor's responsibility to be aware of environmental requirements and the best management practices and pollution control measures necessary to meet them.
- .5 It is the Contractor's responsibility to obtain and abide by permits, licenses and compliance certificates at appropriate times and frequencies as required by the authorities having jurisdiction.
- .6 All hazardous materials are to be stored with secondary containment

1.5 Fires

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

1.6 Disposal of Wastes

- .1 Plan for the re-use, recycling, or disposal of all waste materials as per applicable legislation.
- .2 Do not bury rubbish and waste materials on site.
- .3 Do not dispose of any deleterious substances into waterways, storm or sanitary sewers.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

.1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 References.
- .2 Owner's Regulations.
- .3 Standards and Definitions.
- .4 Designated Substances.
- .5 Hazardous Materials.
- .6 Potable Water Systems.
- .7 Access for Inspection and Testing.
- .8 Other Regulatory Requirements.

1.2 Related Sections

- .1 Section 01 70 03 Safety Requirements

1.3 References

- .1 Perform Work in accordance with the Ontario Building Code Act, O. Reg. 332/12, the Ontario Building Code (OBC) including all Supplements and other codes of provincial or local regulation provided that in case of conflict or discrepancy, more stringent requirements apply.
- .2 Where a material is designated in the Contract Documents for a certain application, unless otherwise specified, that material shall conform to standards designated in the Code. Similarly, unless otherwise specified, installation methods and standards of workmanship shall also conform to standards invoked by the aforementioned Code.
- .3 Meet or exceed requirements of:
 - .1 Contract documents.
 - .2 Specified standards, codes and referenced documents.
 - .3 Manufacturer's instructions.
- .4 Where requirements of Contract Documents exceed Code requirements provide such additional requirements.
- .5 Where the Building Code or the Contract Documents do not provide all information necessary for complete installation of an item, then the manufacturer's instructions for first quality workmanship shall be strictly complied with.

1.4 Owner's Regulations

- .1 Conform to requirements, regulations and procedures of the Owner.

1.5 Standards and Definitions

- .1 Where a reference is made to specification standards produced by various organizations, conform to latest edition of standards, as amended and revised to date of Contract.
- .2 Have a copy of each specified standard which relates to your work available on the site to be produced immediately on Consultant's request.
- .3 Where a standard designates authorities such as the "Engineer", the "Owner" (when used in a sense other than that defined in the General Conditions) the "Purchaser" or some other such designation, these designations shall be taken to mean the Consultant.

- .4 Wherever the words "acceptable", "approved", "satisfactory", "selected", "directed", "inspected", "instructed", "required", "submit", or similar words or phrases are used in standards or elsewhere in the Contract Documents, it shall be understood that they mean, unless the context provides otherwise, "acceptable to the Consultant", "approved by the Consultant", "satisfactory to the Consultant", "selected by the Consultant", "directed by the Consultant", "inspected by the Consultant", "instructed by the Consultant", "required by the Consultant" and "submit to the Consultant".

1.6 Designated Substances

- .1 Known designated substances are identified in the Designated Substance Reports.
- .2 Stop work immediately when material resembling asbestos, mould or any other designated substance which is not identified in the Designated Substance Report is encountered during the course of the work. Notify Owner and Consultant immediately.
- .3 The Owner will arrange for independent testing of suspected designated substances and removal of such substances encountered on the site during the course of the work which are not identified in the Designated Substance Report.

1.7 Hazardous Materials

- .1 Definition: "Hazardous Material" is material, in any form, which by its nature, may be flammable, explosive, irritating, corrosive, poisonous, or may react violently with other materials, if used, handled or stored improperly. Included are substances prohibited, restricted, designated or otherwise controlled by law.
- .2 Hazardous Materials will not be introduced for experimental or any other use prior to being evaluated for hazards.
- .3 Make known to the Consultant those hazardous materials or designated substances intended to be used in the workplace and receive permission to use before introducing to the Owner's property.
- .4 Provide MSDS for all materials brought to the Place of Work.
- .5 Many common construction materials such as asbestos pipe and various insulations are designated substances and shall not be used under any circumstances. Such materials are banned from the Owner's facilities.

1.8 Potable Water Systems

- .1 Potable water systems in completed buildings must meet criteria and guidelines established by Provincial and Municipal authorities, prior to occupancy by the Owner.
- .2 Upon completion, submit testing certificates verifying water quality and water systems meets all applicable Provincial and Legislated Standards

1.9 Access for Inspection and Testing

- .1 Cooperate fully with and provide assistance to, all outside authorities including Building Inspectors, utilities, testing agencies and consultants, with the inspection of the Work.

1.10 Other Regulatory Requirements

- .1 Conform to the requirements of the Ontario Ministry of Transportation, Regional and Local authorities regarding transportation of materials.
- .2 Obtain required road occupancy permits.
- .3 Pay any required roadway damage deposits required by the Municipality.
- .4 Conform to the requirements of the Ontario Ministry of the Environment.
- .5 Conform to the requirements of the Ontario Ministry of Labour.
- .6 Conform to all applicable local by-laws, regulations and ordinances.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Inspection

- .1 Contractor is responsible for Quality Control (QC).
- .2 Allow Owner and Consultant access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .3 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Consultant instructions, or law of Place of Work.
- .4 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .5 Consultant will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Owner shall pay cost of examination and replacement.

1.3 Independent Inspection Agencies

- .1 Independent Inspection/Testing Agencies will be engaged by Contractor for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by the Contractor and paid from the cash allowances specified in Section 01 21 13. Refer to Section 01 29 83.
- .2 Provide equipment required for executing inspection and testing by appointed agencies.
- .3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .4 If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Consultant at no cost to Consultant. Pay costs for retesting and re-inspection.

1.4 Access to Work

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

1.5 Procedures

- .1 Notify Owner and Consultant 48 hours in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.

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

1.6 Rejected Work

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

1.7 Reports

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

1.8 Contractors Responsibilities

- .1 Contractor is responsible for the execution of the Construction Quality Plan and is to pay all costs for the execution of the Construction Quality Plan. Designate an experienced site representative for carrying out the Construction Quality Plan.

1.9 Mock Ups

- .1 Prepare mock-ups for Work specifically requested in specifications.
- .2 Construct in locations acceptable to Consultant.
- .3 Prepare mock-ups for Consultant's review with reasonable promptness and in orderly sequence, to not cause delays in Work.
- .4 Failure to prepare mock-ups in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .5 Mock-ups may remain as part of Work unless indicated otherwise.

1.10 Equipment and Systems

- .1 Submit adjustment and balancing reports for mechanical, electrical and building equipment systems.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

.1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Appointment and payment.
- .2 Manufacturer's field review.

1.2 Related Sections

- .1 Particular requirements for testing and inspection to be carried out by testing laboratory designated by the Consultant are specified under various sections of the specifications.
- .2 Balancing and testing of systems under Divisions 21 through 28.

1.3 Appointment and Payment

- .1 From time to time during the progress of the Work, the Owner will require that testing and inspection be performed to determine that materials provided in the Work meet the requirements of the Contract Documents.
 - .1 Subcontractors shall verify with Contractor, in writing, portions of the Work that will require testing and/or inspection prior to commencing such affected work.
- .2 The Owner will appoint testing and inspection companies, representing, reporting and responsible to the Owner. Cost of testing and inspection will be authorized as a disbursement of the Cash Allowances as specified in Section 01 21 13 unless otherwise indicated or specified and except for the following:
 - .1 Testing and inspection required by laws, ordinances, rules, regulations or orders of public authorities.
 - .2 Testing and inspection performed exclusively for Contractor's convenience.
 - .3 Testing, adjusting and balancing of conveying systems, mechanical and electrical equipment and systems. Refer to mechanical specifications for in-contract air-balancing.
 - .4 Mill tests and certificates of compliance.
 - .5 Tests specified to be carried out by Contractor under supervision of the Consultant.
 - .6 Where tests or inspections by designated testing laboratory reveal work not in accordance with the Contract requirements, Contractor shall pay costs for additional tests or inspections as Consultant may require to verify acceptability of corrected work.
 - .7 Additional testing required because of changes in materials, proportions of mixes, requested by the Contractor or Subcontractors as well as any extra testing of materials occasioned by lack of identification or failure of such materials being replaced to meet requirements of the Contract Documents or testing of structure or elements including load testing, shall be carried out at no additional cost to the Owner.
 - .8 Where evidence exists that defective workmanship has occurred or that the Work has been carried out incorporating defective materials, the Consultant reserves the right to have tests, inspections or surveys performed, analytical calculation of structural strength made and the like in order to help determine the extent of defect and whether such work must be replaced. Tests, inspections or surveys carried out under these circumstances will be made at the Contractor's expense and will not be paid for by the Owner.
 - .9 Testing and compliance letters specified in other Sections.
- .3 Inspection and testing company shall submit monthly invoice original to the Contractor for review, relating invoices to tests and inspection reports. Provide original receipts for disbursements. Invoices will be forwarded by Contractor to the Consultant for inclusion in progress payment application.

- .4 The Consultant will work with the Owner's representative and the Contractor's commissioning team to review the work of the Contract during closeout procedures. The Contractor shall be responsible to correct all deficiencies as reported by the Consultant and Owner's representative, and in accordance with the Contract documents. Refer to Sections 01 77 00 for additional closeout requirements.
- .5 Testing and Inspection shall be performed by qualified and/or certified personnel under professional supervision or performed directly by a professional engineer qualified in conformance with applicable codes and certification programs.
- .6 Requirements of regulatory agencies:
 - .1 Testing shall be conducted in accordance with the requirements of the Building Code.
 - .2 Obtain certification where required by the building code and standards.
- .7 Cooperation with testing and inspection company.
 - .1 Provide inspection company with materials and installation information as required or as requested.
 - .2 Provide access to the work for representatives of the inspection and testing companies.
 - .3 Provide storage on site for laboratory's exclusive use to store equipment and cure test samples.
 - .4 Cooperate with testing and inspection companies and give adequate notification of any changes in source of supply, additional work shifts or other proposed changes.
 - .5 No Product nor part of the Work shall be installed before it is tested when a test is specified or required, nor shall work be executed where a test or inspection is required and the inspector cannot attend. Pay costs for uncovering and making good work that is covered before required inspection or testing is completed and approved by the Consultant.
 - .6 Cooperate in permitting access to the Work for testing and inspection company wherever Work is in progress, or wherever Products, materials or equipment are stored prior to shipping.
 - .7 Supply labour required to assist testing and inspection company in sampling and making tests.
 - .8 Repair work damaged as a result of testing and inspection work.
 - .9 Costs of above labour and material shall be borne by applicable Subcontractors.
 - .10 The testing and inspection service does not relieve the Contractor of responsibility for normal shop and site inspection, and quality control of production.
 - .11 Pay costs for removal and replacement of Work, or for remedial measures necessitated by faulty workmanship and materials which fail to meet requirement specified.
- .8 Prepare schedule for testing and inspection in accordance with Section 01 33 00 and as follows:
 - .1 Establishing Schedule:
 - .1 By advance discussion with the selected testing laboratory, determine the time required by the laboratory to perform its tests and issue each of its findings.
 - .2 Allow required time within Construction Schedule
 - .2 Adherence to Schedule:
 - .1 Contractor shall advise testing and inspection laboratory in advance when testing of the Work is required.
 - .2 When testing and inspection laboratory is ready to test according to predetermined schedule, but is prevented from testing or taking specimens due to incompleteness of the parts of the Work scheduled for testing and inspection, extra costs for testing attributable to the delay may be back-charged to the Contractor at no increase in the Contract Price.
 - .3 Notify Contractor and inspection company at least 3 Working Days before work required to be inspected commences, and arrange for a meeting at the Place of the Work, to be held one Working day before the work starts with the following present:
 - .1 Contractor, a principal of the Sub-contractor whose work is to be inspected or tested,

- testing and inspection company, manufacturer's representative and Consultant.
- .4 Give 2 Working Days prior notice to inspection company of the commencement of each phase of the Work requiring inspection and provide inspection company with materials and installation information.
- .9 Reports and Documents:
- .1 Testing and Inspection companies shall submit shop inspection and site inspection reports within 5 Working days of each inspection.
 - .2 Distribute reports as follows:
 - .1 Owner.
 - .2 Consultant.
 - .3 Contractor.
 - .4 Consulting engineers as applicable.
 - .3 Inspectors shall submit a written report on each inspection or test, including pertinent data such as conditions at the Place of the Work, dates, test references, locations of tested materials, actual product identification, procedures and descriptions, site instructions given, recommendations and/or any other information required by standard applicable reporting of tests and inspections.
 - .4 Clearly indicate in report failure of Product or procedures to meet applicable standards, give recommendations for retesting or correction. Contact Consultant immediately when Product or procedure fails to meet applicable standards.
 - .5 Upon completion of those parts of the Work subject to independent testing and inspection, submit to the Consultant duplicate certificates of acceptance of the installation issued by independent testing and inspection company.
- .10 Inspection and Test Specimens:
- .1 Testing and inspection will generally consist of procedures listed in the following paragraphs, but additional tests may be performed as required to verify conformance to Contract Documents.
 - .2 Specimens and samples for testing, unless otherwise specified in the Contract Documents, will be taken by the testing laboratory; sampling equipment and personnel will be provided by the testing laboratory; and deliveries of specimens and samples to the testing laboratory will be performed by the testing laboratory.
 - .3 Testing and inspection company shall take samples necessary to verify quality as specified by applicable standards or as specified herein. Taking of samples shall not endanger the structure or life and shall be taken so as to best represent the Work as a whole.
 - .4 Samples shall be handled, packaged, stored and delivered so as to best ensure the validity of tests that will be performed on them. Sample handling where required shall duplicate conditions at the Place of the Work (such as site cured concrete cylinders).
- 1.4 Manufacturer's Field Review
- .1 Where manufacturer's field review is specified, manufacturer's representative shall review the relevant parts of work at the Place of Work, or wherever such affected work is in progress, to ensure that work is being executed in accordance with manufacturer's written recommendations.
 - .2 Manufacturer's field review is to ensure that the Products specified are being used in the Work and are being applied on surfaces prepared in accordance with their recommendations and the requirements of the Contract Documents.
 - .3 Manufacturer's representative shall undertake such review weekly, or additionally as necessary, to determine that the work is in accordance with manufacturer's written recommendations.
 - .4 Manufacturer's representative shall submit a type written report on manufacturer's letterhead

within 2 Working Days after each field review. Report shall document manufacturer's representative's field observations and recommendations.

- .5 Manufacturer's field review reports to be prepared and distributed following the procedures specified for pe reparation and submittal of testing and inspection reports given above.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Section Includes

- .1 Temporary utilities.

1.3 Related Sections

- .1 Section 01 52 00 Construction Facilities.
- .2 Section 01 56 00 Temporary Barriers and Enclosures

1.4 Installation and Removal

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

1.5 Water Supply

- .1 Provide continuous supply of water for construction use.
- .2 Arrange for connection with local utility company and pay all costs for installation, maintenance and removal.
- .3 Pay all utility charges.
- .4 Conveniently locate water supply for use by all sections of the work. Protect water lines from freezing.
- .5 Water shall be potable and shall meet the requirements of the technical sections of the specifications.

1.6 Temporary Heating and Ventilation

- .1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.
- .2 Construction heaters used inside building must be vented to outside or be flameless type. Solid fuel salamanders are not permitted, unless prior approval is given by the Consultant.
- .3 Provide temporary heat and ventilation in enclosed areas as required to:
 - .1 Facilitate progress of Work.
 - .2 Protect Work and products against dampness and cold.
 - .3 Prevent moisture condensation on surfaces.
 - .4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
 - .5 Provide adequate ventilation to meet health regulations for safe working environment.
- .4 Maintain temperatures of minimum 10° C in areas where construction is in progress.

- .5 Ventilating:
 - .1 Prevent accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction.
 - .2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
 - .3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
 - .4 Ventilate storage spaces containing hazardous or volatile materials.
 - .5 Ventilate temporary sanitary facilities.
 - .6 Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful contaminants.
 - .6 Permanent heating system of building, may be used when available.
 - .7 On completion of Work for which permanent heating system is used, replace filters.
 - .8 Ensure Date of Substantial Performance and Warranties for heating system do not commence until entire system is in as near original condition as possible and is certified by Consultant.
 - .9 Pay costs for maintaining temporary heat, when using permanent heating system. Owner will pay utility charges when temporary heat source is existing building equipment.
 - .10 Maintain strict supervision of operation of temporary heating and ventilating equipment to:
 - .1 Conform to applicable codes and standards.
 - .2 Enforce safe practices.
 - .3 Prevent abuse of services.
 - .4 Prevent damage to finishes.
 - .5 Vent direct fired combustion units to outside.
 - .11 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.
- 1.7 Temporary Power and Light
- .1 Provide and pay for all temporary power during construction.
 - .2 Arrange for connection with utility company. Pay all costs for installation, maintenance and removal.
 - .3 Provide and maintain temporary lighting throughout project. Lighting levels shall be sufficient to complete work including inspections. Provide minimum lighting levels of 400 lux at work areas. Lighting levels at floors and stairs not within work areas shall be not less than 160 lux at all times during construction activity.
 - .4 All equipment used shall be CSA approved.
 - .5 Wiring and method of installation shall conform to local power requirements and shall be reviewed by a licensed inspector prior to use.
- 1.8 Temporary Communication Facilities
- .1 Provide and pay for temporary telephone, fax, data hook up, lines and equipment necessary for own use.

1.9 Fire Protection

- .1 Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction and governing codes, regulations and bylaws.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Construction aids.
- .2 Offices and sheds.
- .3 Parking.
- .4 Project identification.

1.2 References

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA Z321-96 (R2006), Signs and Symbols for the Workplace

1.3 Installation and Removal

- .1 Provide construction facilities in order to execute work expeditiously.
- .2 Remove from site all such work after use.

1.4 Site Storage/Loading

- .1 Do not unreasonably encumber premises with products.
- .2 Do not load or permit to load any part of Work with a weight or force that will endanger the Work.

1.5 Construction Parking

- .1 Parking will be permitted on site at areas designated by the Owner provided it does not disrupt performance of Work or ongoing Owners operations.
- .2 Provide and maintain adequate access to project site.
- .3 If authorized to use existing roads for access to project site, maintain such roads for duration of Contract and make good damage resulting from Contractors' use of roads.

1.6 Offices

- .1 General Contractor may provide their own offices as necessary and subject to site constraints. Direct location of these offices.

1.7 Equipment, Tool and Material Storage

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

1.8 Sanitary Facilities

- .1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.
- .2 Post notices and take such precautions as required by local health authorities. Keep area and

premises in sanitary condition.

1.9 Construction Signage

- .1 Direct requests for approval to erect a Contractor signboard to Consultant.
- .2 Signs and notices for safety and instruction shall be in English. Graphic symbols shall conform to CAN/CSA Z321-96 (R2006).
- .3 Maintain approved signs and notices in good condition for duration of project, and dispose of off-site on completion of project.

1.10 Shoring

- .1 Contractor shall formulate his own conclusions as to the extent of the existing conditions and shoring required.
- .2 The method of shoring shall be according to the Contractor's and his Engineer's directions.
- .3 All existing loads must be shored prior to commencement of demolition and removal of load bearing elements.
- .4 All shoring and frame braces must be supplied with a safe load rating which must not be exceeded. Install in accordance with manufacturer's recommended procedures and safety guidelines. Ensure that the safe load conditions of the shoring are not exceeded by dead, live or construction loads.
- .5 All shoring shall be subject to the Consultant's review and approval prior to commencing demolition work.
- .6 Completely remove all shoring after new structure is installed and all concrete is set.
- .7 Submit shoring drawings and a proposed installation procedure stamped by a professional engineer registered in the Province of Ontario. Procedures shall follow the information provided on these drawings. The shoring design engineer shall be retained and paid for by the Contractor. The shoring engineer shall review all existing conditions on site prior to completing shoring design.
- .8 Removal of existing materials without proper engineered shoring is a safety hazard and will not be permitted.
- .9 Make good all damage to the adjoining structures and bear full responsibility for failure to provide adequate shoring.
- .10 The failure or refusal of the Consultant to suggest the use of shoring, shall not in any way or to any extent relieve the Contractor of any responsibility concerning the condition of the work or of any of their obligations under the Contract, nor impose any liability on the Owner or their agents; nor shall any delay, whether caused by any action or want of action on the part of the Contractor, or by any act of the Owner, or their agents, or employees, relieve the Contractor from necessity of properly and adequately protecting the existing structure from collapse or damage, nor from and of his obligations under the Contract relating to injury to persons or property, nor entitle him to any claims for extra compensation or an extension in schedule.

PART 2 PRODUCTS

2.1 Not Used

.1 Not used

PART 3 EXECUTION

3.1 Not Used

.1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Barriers.
- .2 Environmental Controls.
- .3 Traffic Controls.
- .4 Fire Routes.

1.2 Installation and Removal

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

1.3 Hoarding

- .1 Erect temporary enclosures where required using new solid plywood hoarding, minimum 1.8 metres high. Provide gates as necessary. Maintain hoarding in good repair.

1.4 Guard Rails and Barricades

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

1.5 Dust Tight Screens

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

1.6 Access to Site

- .1 Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required for access to Work.
- .2 Maintain access for staff, students and visitors to the existing school and designated school areas.

1.7 Public Traffic Flow

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

1.8 Fire Routes

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

1.9 Protection for Off Site and Public Property

- .1 Protect surrounding private and public property from damage during performance of Work.

- .2 Be responsible for damage incurred

1.10 Protection of Building Finishes

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

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Product quality, availability, storage, handling, protection, and transportation.
- .2 Manufacturer's instructions.
- .3 Quality of Work, coordination and fastenings.
- .4 Existing Utilities

1.2 Quality

- .1 Products, materials, equipment and articles (referred to as products throughout specifications) incorporated in Work shall be new, not damaged or defective, and of best quality (compatible with specifications) for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.
- .2 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.
- .3 Should any dispute arise as to quality or fitness of products, decision rests strictly with Consultant based upon requirements of Contract Documents.
- .4 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .5 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.3 Availability

- .1 Review product delivery requirements and anticipate foreseeable supply delays for any items. If delays in supply of products are foreseeable, notify Consultant of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
- .2 In event of failure to notify Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Consultant reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

1.4 Storage, Handling and Protection

- .1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden

platforms and cover with waterproof tarpaulins during inclement weather.

- .6 Store sheet materials and lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged products at own expense and to satisfaction of Consultant.
- .9 Touch up damaged factory finished surfaces to Consultant's satisfaction. Use touch up materials to match original. Do not paint over name plates.

1.5 Transportation

- .1 Pay costs of transportation of products required in performance of Work.
- .2 Transportation cost of products supplied by Owner will be paid for by Owner. Contractor shall be responsible for the unloading, handling and storage of such products.

1.6 Manufacturer's Instructions

- .1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.
- .2 Notify Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant may establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Consultant to require removal and re installation at no increase in Contract Price or Contract Time.

1.7 Quality of Work

- .1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed.
- .2 Immediately notify Consultant if required Work is such as to make it impractical to produce required results.
- .3 Do not employ anyone unskilled in their required duties. Consultant reserves right to require dismissal from site, workers deemed incompetent or careless.
- .4 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Consultant, whose decision is final.

1.8 Coordination

- .1 Ensure cooperation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.

1.9 Concealment

- .1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation, inform Consultant if there is interference. Install as directed by Consultant.

1.10 Remedial Work

- .1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Coordinate adjacent affected Work as required.
- .2 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

1.11 Location of Fixtures

- .1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
- .2 Inform Consultant of conflicting installation. Install as directed.

1.12 Fastenings

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use non corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.
- .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.13 Fastenings – Equipment

- .1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- .2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.
- .3 Bolts may not project more than one diameter beyond nuts.
- .4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

1.14 Protection of Work in Progress

- .1 Adequately protect Work completed or in progress. Work damaged or defaced due to failure in providing such protection is to be removed and replaced, or repaired, as directed by Consultant, at no increase in Contract Price or Contract Time.
- .2 Prevent overloading of any part of building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated without written approval of Consultant.

1.15 Existing Utilities

- .1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, and/or building occupants and pedestrian and vehicular traffic.
- .2 Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.

1.16 Hazardous Materials

- .1 Report any found or suspected hazardous materials to the Owner.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Safety Requirements
- .2 Fire Protection
- .3 Accident Reporting
- .4 Records on Site

1.2 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit to Owner and Consultant copies of the following documents, including updates issued:
 - .1 Site-specific Health and Safety Plan prior to commencement of work on the work site.
 - .2 Fire Safety Plan.
 - .3 Reports or directions issued by authorities having jurisdiction, immediately upon issuance from that authority.
 - .4 Accident or Incident Reports, within 24 hours of occurrence.
- .3 Submit other data, information and documentation upon request by the Consultant as stipulated elsewhere in this section.

1.3 Compliance Requirements

- .1 Comply with the latest edition of the Ontario Occupational Health and Safety Act, and the Regulations made pursuant to the Act.

1.4 Safety Requirements

- .1 Observe and enforce all construction safety measures and comply with the latest edition and amending regulations of the following documents and in the event of any differences among those provisions, the most stringent shall apply:
 - .1 Occupational Health and Safety Act and Regulations for Construction Projects, August 1997, Ontario Regulation 213/91 including amendments.
 - .2 Hazardous Products Act and Canada Labour Code.
 - .3 The Workplace Safety and Insurance Board, O-Reg 454.
 - .4 Ontario Building Code Act, Ontario Regulation 332/12 including amendments.
 - .5 National Building Code of Canada, Part 8: Safety Measures on Construction and Demolition Sites.
 - .6 National Fire Code of Canada.
 - .7 Environmental Protection Act.
 - .8 The Power Commission Act.
 - .9 The Boiler and Pressure Vessels Act.
 - .10 The Elevators and Lifts Act.
 - .11 The Operating Engineer's Act.
 - .12 Municipal statutes.
- .2 Obey all Federal, Provincial and Municipal Laws, Acts, Statutes, Regulations, Ordinances and By-laws which could in any way, pertain to the work outlined in the Contract, or to any employees of the Contractor. Satisfy all statutory requirements imposed by the Occupational Health and Safety Act and Regulations made thereunder, on a Contractor, and Constructor and/or Employer with respect to or arising out of the performance of the Contractors obligations under this Contract.

- .3 The Contractor will be the "Constructor" as defined by the Occupational Health and Safety Act, will file a Notice of Project with the Ontario Ministry of Labour prior to commencement of the work and will pay all associated fees.
- .4 Confined Space: Where applicable, provide the Consultant and all Regulatory Authorities with a copy of the Contractors' Confined Space Entry Procedure. In the event that defined procedures are not available, abide by the applicable requirements of the Occupational Health and Safety Act and all regulations made thereunder.
- .5 The supervisor of the project, will be responsible for his employees and subcontractors/suppliers maintaining standard safety practices, as well as the specific safety rules listed below, while working on the Owner's property.
- .6 The Owner reserves the right to order individuals to leave the site if the individual is in violation of any safety requirement or any Act, and any expense incurred will be the responsibility of the Contractor.
- .7 Notify the Owner should any hazardous condition become apparent.
- .8 Enforce the use of CSA approved hard hats and safety boots for all persons entering or working at the construction site. Refuse admission to those refusing to conform to this requirement.
- .9 Provide safeguard and protection against accident or injury to any person on the site, adjacent work areas and adjacent property.
- .10 Provide safeguard and protection against damage to adjacent structures, properties and services.

1.5 Fire Protection

- .1 Provide safeguard and protection against fire in accordance with current fire codes and regulations.
- .2 Provide temporary fire protection throughout the course of construction. Particular attention shall be paid to the elimination of fire hazards.
- .3 Comply with the requirements of FCC No. 301 Standards for Construction Operations issued by the Fire Commissioner of Canada and the National Building Code.
- .4 Prior to construction, submit to the Owner, Consultant and Municipal Fire Department, for review, a "Fire Safety Plan" conforming to Section 2.14 of the National Fire Code of Canada. Maintain a copy of the "Fire Safety Plan" on site.
- .5 Provide and maintain portable fire extinguishers during construction, in accordance with Part 6 of the National Fire Code of Canada.
- .6 Maintain unobstructed access for firefighting at all areas in accordance with the National Building Code of Canada.

1.6 Accident Reporting

- .1 Investigate and report incidents and accidents as required by Occupational Safety and Health Act, and the Regulations made pursuant to the Act.
- .2 For the purpose of this contract immediately investigate and provide a report to the Consultant on incidents and accidents that involve:

- .1 A resulting injury that may or may not require medical aid but involves lost time at work by the injured person(s).
- .2 Exposure to toxic chemicals or substances.
- .3 Property damage.
- .4 Interruption to adjacent and/or integral infrastructure operations with potential loss implications.

1.7 Records on Site

- .1 Maintain on site a copy of the safety documentation as specified in this section and any other safety related reports and documents issued to or received from the authorities having jurisdiction.
- .2 Upon request, make copies available to the Consultant.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 Existing Services

- .1 Before commencing work, establish location and extent of service lines in area of Work and notify Consultant of findings. The Contractor is responsible for coordination of all utility locates.
- .2 Where Work involves breaking into or connecting to existing services, carry out work at times directed by authorities having jurisdiction, with minimum of disturbance to building occupants, pedestrian and vehicular traffic.
- .3 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.

1.2 Location of Services, Equipment and Fixtures

- .1 Location of services, equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform Consultant of impending installation and obtain approval for actual location.
- .4 Submit field drawings to indicate relative position of various services and equipment when required by Consultant. Refer to requirements for interference drawings specified elsewhere.
- .5 Location of site services where required, is approximate and is based on information provided by the Owner. Undertake all locates to determine exact locations of existing services, and lay out new services to avoid any conflicts with new building elements, including site improvements, building foundations and other new or existing services.
- .6 Submit field drawings and interference to indicate relative position of various services and equipment.
- .7 Prepare interference and equipment placing drawings to ensure that all components will be properly accommodated within the spaces provided.
- .8 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.
- .9 Ensure that clearances required by jurisdictional authorities and clearances for proper maintenance and access are indicated and maintained.
- .10 Submit two copies of interference drawings to Owner and Consultant in accordance with Section 01 33 00.

1.3 Records

- .1 Maintain a complete, accurate log of control work as it progresses.
- .2 Record locations of maintained, re-routed and abandoned service lines.

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit documentation to verify accuracy of field engineering work.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Requirements and limitations for cutting and patching the Work.

1.2 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit written request and obtain Consultant's approval in advance of cutting or alteration which affects:
 - .1 Structural integrity of any element of Project.
 - .2 Integrity of weather exposed or moisture resistant elements.
 - .3 Efficiency, maintenance, or safety of any operational element.
 - .4 Visual qualities of sight exposed elements

1.3 Materials

- .1 Required for original installation.
- .2 Change in Materials: Submit request for substitution in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Requests for change in materials shall include documentation indicating conformance to project requirements and intent.

1.4 Preparation

- .1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .2 After uncovering, inspect conditions affecting performance of Work.
- .3 Beginning of cutting or patching means acceptance of existing conditions.
- .4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.
- .5 Provide protection from elements for areas which may be exposed by uncovering work; maintain excavations free of water.

1.5 Execution

- .1 Execute cutting, fitting, and patching including excavation and fill, to complete Work.
- .2 Fit several parts together, to integrate with other Work.
- .3 Uncover Work to install ill-timed Work.
- .4 Remove and replace defective and non-conforming Work.
- .5 Provide cutting and patching of all openings in non-structural elements of Work as necessary to complete installation of mechanical and electrical Work. Include complete removal and

replacement of such elements as necessary to provide construction access.

- .6 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .7 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
- .8 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools are not allowed on masonry work without prior approval.
- .9 Restore work with new products in accordance with requirements of Contract Documents.
- .10 Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .11 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with "ULC approved firestopping material, full thickness of the construction element.
- .12 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.
- .13 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Progressive Cleaning
- .2 Final Cleaning

1.2 Project Cleanliness

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris.
- .2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by the Owner. Do not burn waste materials on site.
- .3 Clear snow and ice from access to building, bank/pile snow in designated areas only.
- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5 Provide on-site containers for collection of waste materials and debris.
- .6 Provide and use clearly marked separate bins for recycling.
- .7 Remove debris daily. The work site must be left clean and tidy upon completion, to the satisfaction of the Consultant.
- .8 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .9 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .10 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .11 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

PART 2 PRODUCTS

2.1 General

- .1 All cleaning materials and products shall be low VOC type. Submit list of cleaning products including MSDS for approval prior to commencement of cleaning operations.
- .2 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

PART 3 EXECUTION

3.1 Final Cleaning

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.

- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .5 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, floors and ceilings.
- .6 Clean lighting reflectors, lenses, and other lighting surfaces.
- .7 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .8 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- .9 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .10 Clean equipment and fixtures to a sanitary condition; clean or replace filters of mechanical equipment.

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 References.
- .2 Submittals.
- .3 Definitions.
- .4 Waste Management Goals for the Project.
- .5 Documents.
- .6 Waste Management Plan.
- .7 Waste Audit.
- .8 Waste Reduction Work Plan.
- .9 Materials Source Separation Program.
- .10 Disposal of Wastes.
- .11 Scheduling.
- .12 Storage, Handling and Protection.
- .13 Application.
- .14 Diversion of Materials.

1.2 Related Sections

- .1 Section 01 33 00 Submittal Procedures
- .2 Section 01 35 43 Environmental Procedures
- .3 Section 01 74 11 Cleaning

1.3 References

- .1 O. Reg. 102/94, Waste Audits and Waste Reduction Work Plans.

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit 2 copies of completed Waste Management Plan (WMP) including Waste Reduction Workplan (WRW) and Materials Source Separation Program description prior to project start-up.

1.5 Definitions

- .1 Waste Management Plan (WMP): Contractor's approved overall strategy for waste management including waste audit, waste reduction workplan and materials source separation program.
- .2 Waste Audit (WA): Relates to projected waste generation. Involves measuring and estimating quantity and composition of waste, reasons for waste generation, and operational factors which contribute to waste.
- .3 Waste Reduction Work Plan (WRW): Written report which addresses opportunities for reduction, reuse, or recycling of materials. WRW is based on information acquired from WA.
- .4 Materials Source Separation Program (MSSP): Consists of a series of ongoing activities to separate reusable and recyclable waste material into material categories from other types of waste at point of generation.

- .5 Waste Management Coordinator (WMC): Designate individual who is in attendance on-site, full-time. Designate, or have designated, individuals from each Subcontractor to be responsible for waste management related to their trade and for coordinating activities with WMC.

- .6 Separate Condition: Refers to waste sorted into individual types.

1.6 Waste Management Goals for the Project

- .1 The Owner has established that this Project shall generate the least amount of waste possible and that processes shall be employed that ensure the generation of as little waste as possible including prevention of damage due to mishandling, improper storage, contamination, inadequate protection or other factors as well as minimizing over packaging and poor quantity estimating.
- .2 Of the inevitable waste that is generated, the waste materials designated in this specification shall be salvaged for reuse and or recycling. Waste disposal in landfills or incinerators shall be minimized.

1.7 Documents

- .1 Maintain at job site, one copy of following documents:
 - .1 Waste Audit
 - .2 Waste Reduction Workplan
 - .3 Material Source Separation Plan

1.8 Waste Management Plan

- .1 Waste Management Plan: Within 10 calendar days after receipt of Notice of Award of Contract, or prior to any waste removal, whichever occurs sooner, submit to the Owner and Consultant a Waste Management Plan. The Plan shall contain the following:
 - .1 Analysis of the proposed job site waste to be generated, including the types of recyclable and waste materials generated (by volume or weight). In the case of demolition, a list of each item proposed to be salvaged during the course of the project should also be prepared
 - .2 Alternatives to Land Filling: Contractor shall designate responsibility for preparing a list of each material proposed to be salvaged, reused, or recycled during the course of the Project.
- .2 Post WMP or summary where workers at site are able to review its content.

1.9 Waste Audit

- .1 Prepare Waste Audit prior to project start-up.
- .2 Record, on Waste Audit , extent to which materials or products used consist of recycled or reused materials or products

1.10 Waste Reduction Work Plan

- .1 Prepare WRW prior to project start-up.
- .2 Reduce construction and demolition waste in compliance with O. Reg. 102/94.

- .3 Reduction will involve action to minimize quantity of waste at source. Reuse products which would become waste where practical. Recycling will involve collection and source separation at the site, of materials for use as feedstock in manufacturing of new products.
- .4 Conform to local Municipal Landfill Solid waste management requirements. Consider reduction, reuse and recycling of waste generated during construction such as dimensional lumber, clean drywall, concrete, brick, scrap metal and corrugated cardboard.

1.11 Materials Source Separation Program

- .1 The Waste Management Plan shall include a Source Separation Program for recyclable waste, and shall be in accordance with the established policies currently in place at the local Municipality, and the requirements of O. Reg. 102/94.
- .2 Prepare MSSP and have ready for use prior to project start-up.
- .3 Implement MSSP for waste generated on project in compliance with approved methods and as approved by Consultant.
- .4 Provide on-site facilities for collection, handling, and storage of anticipated quantities of reusable and/or recyclable materials.
- .5 Provide containers to deposit reusable and/or recyclable materials.
- .6 Locate containers to facilitate deposit of materials without hindering daily operations.
- .7 Locate separated materials in areas which minimize material damage.
- .8 Collect, handle, store on-site, and transport off-site, salvaged materials in separate condition.

1.12 Disposal of Wastes

- .1 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .2 Provide appropriate on-site containers for collection of waste materials and debris.
- .3 Provide and use clearly marked separate bins for recycling.
- .4 Remove waste materials from site at regularly scheduled times or dispose of as directed by Consultant. Do not burn waste materials on site.
- .5 Remove waste material and debris from site and deposit in waste container at end of each working day.
- .6 Do not permit waste to accumulate onsite.
- .7 Burying of rubbish and waste materials is prohibited.
- .8 Disposal of waste into waterways, storm, or sanitary sewers is prohibited.

1.13 Scheduling

- .1 Coordinate work with other activities at site to ensure timely and orderly progress of the Work.

1.14 Storage, Handling and Protection

- .1 Store, materials to be reused, recycled and salvaged in locations as directed by Owner.
- .2 Materials from building demolition to be salvaged or re-used are to be removed and salvaged.
- .3 Unless specified otherwise, materials for removal become Contractor's property.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Application

- .1 Do work in compliance with Waste Management Plan.
- .2 Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes.
- .3 Source separate materials to be reused/recycled into specified sort areas.

3.2 Designated Substances

- .1 Refer to disposal requirements and Designated Substances reports listed in Section 02 41 00- Demolition.

3.3 Diversion of Materials

- .1 Separate materials from general waste stream and stockpile in separate piles or containers, to approval of Owner, and consistent with applicable fire regulations. Mark containers or stockpile areas. Provide instruction on disposal practices.
- .2 On-site sale of materials is not permitted.

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 Administrative procedures preceding preliminary and final inspections of Work.

1.2 Related Sections

- .1 Closeout Submittals Section 01780

1.3 References

- .1 Canadian Construction Documents Committee CCDC 2-2008, Stipulated Price Contract including Supplementary Conditions.
- .2 OAA/OGCA Document 100 - Recommended procedures regarding Substantial Performance of Construction Contracts and Completion Takeover of Projects.
- .3 The Construction Lien Act.

1.4 Inspection and Declaration

- .1 Contractor's Inspection: The Contractor and all Sub-contractors shall conduct an inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents. Submit duplicate copies of the deficiency list to the Owner and Consultant.
 - .1 Notify Consultant in writing of satisfactory completion of Contractor's Inspection and that corrections have been made.
 - .2 Request Consultant's review.
- .2 Consultant's Review: Consultant and Contractor will perform review of Work to identify obvious defects or deficiencies. Contractor shall correct Work accordingly.
- .3 Completion: submit written certificate that following have been performed:
 - .1 Work has been completed and inspected for compliance with Contract Documents.
 - .2 Defects have been corrected and deficiencies have been completed.
 - .3 Equipment and systems have been tested, adjusted and balanced and are fully operational.
 - .4 Certificates required by Boiler Inspection Branch, Fire Commissioner, Utility companies, TSSA and other regulatory agencies have been submitted.
 - .5 Operation of systems have been demonstrated to Owner's personnel.
 - .6 Work is complete and ready for Final Review by the Consultant.
- .4 Final Inspection: when items noted above are completed, request final review of Work by Consultant, and Contractor. If Work is deemed incomplete by the Consultant, complete outstanding items and request re-review.
- .5 Declaration of Substantial Performance: when Consultant consider deficiencies and defects have been corrected and it appears requirements of Contract have been substantially performed, make application for certificate of Substantial Performance. Refer to CCDC 2, General Conditions Article GC 5.4 - Substantial Performance of Work and the Construction Lien Act for specifics to application.
- .6 Commencement of Lien and Warranty Periods: date of Owner's acceptance of submitted declaration of Substantial Performance shall be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of Place of Work.
- .7 Final Payment: When Consultant considers final deficiencies and defects have been corrected and it appears requirements of Contract have been totally performed, make application for final

payment. Refer to CCDC 2, General Conditions Article GC 5.7 for specifics to application.

- .8 Payment of Holdback: After issuance of certificate of Substantial Performance of Work, submit an application for payment of holdback amount in accordance with CCDC 2, General Conditions Article 5.5

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 Not Used

- .1 Not used

End of Section

PART 1 GENERAL

1.1 Section Includes

- .1 As built drawings, samples, and specifications.
- .2 Equipment and systems.
- .3 Product data, materials and finishes, and related information.
- .4 Operation and maintenance data.
- .5 Spare parts, special tools and maintenance materials.
- .6 Warranties.
- .7 Specialty Engineers sign off.
- .8 Final site survey.

1.2 Submittals

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

1.3 Definitions

- .1 As-Built Drawings are those prepared by the Contractor as it constructs the project and upon which it documents the actual locations of the building components and site components and changes to the original contract documents.
- .2 Record Drawings are those drawings prepared by the Consultant. These are the compendium of the original drawings, site changes known to the Consultant, and information taken from the Contractor's As-Built Drawings.
- .3 The above definitions are founded on the OAA Joint Best practices Statement As-Built and Record Drawings dated October 21, 2010 and issued jointly by the OAA and the Ontario General Contractors Association.

1.4 General

- .1 The General Contractor shall assemble and submit the following close-out submittals for approval:
 - .1 General Drawings (GD) manual containing project components that are static, not operational in nature or do not require routine scheduled maintenance.
 - .2 Operation and Maintenance (O&M) manual containing operating systems with moving parts or safety systems requiring regularly scheduled inspection, maintenance or monitoring.
 - .3 Warranty Manual
 - .4 Complete drawing file containing as-built drawing and Autocad site record drawings.
 - .5 Maintenance material receipts.
 - .6 Owners signed certificate that specified training has been provided and accepted.
- .2 Document close-out submittals shall be submitted on a single labelled write-protected USB flash drive labelled "Closeout Documents" with:
 - .1 Project Title;
 - .2 Project Job Number;
 - .3 Date
- .3 The USB flash drive shall be fully indexed and shall include:
 - .1 File Folders and subfolders created for content itemized in 3.1.
 - .2 Table of Contents for each manual.

- .4 All pdf content must be legible. Poor resolution content shall be substantiation for rejection of the entire submission.
- .5 Autocad drawings shall be created using version 2007 or later. Where contract drawings are created in BIM, the BIM model shall be modified. PDF format shall be version 7.0 or later.
- .6 Closeout submittals are to be delivered for review a minimum of 14 calendar days prior to application for certificate of Substantial Performance. Time frame is to allow the Owner to coordinate review of submission by the consultant and the owner. Consultant will review selected items. Consultant is reviewing that required as-built drawings, shop drawings, product data and warranties are included and that they are the approved version.
- .7 Only copies of reviewed shop drawings and product data are to be submitted. Rejected and not reviewed shop drawings and product data are not to be included.
- .8 Shop drawings for temporary works required to facilitate construction and that will be removed during or at the completion of construction do not have to be submitted in closeout submittals.
- .9 Consultant may reject the closeout submission for failure to meet the quality or organizational requirements listed in this specification.
- .10 The pdf document files of the GD Manual, O&M Manual and Warranty Manual shall be bound and securely protected so that content cannot be removed or added to each manual but only viewed or printed.
- .11 Improper Content or organization shall be substantiation for rejection of the entire submission.
- .12 Supplementary content such as tab pages and table of contents to organize and coordinate the file folders and manuals shall be created using typed text.

1.5 General Drawings (GD) Manual

- .1 GD Manual file folder shall include but not be limited to the following content: building envelope, structure, static Building, Civil, Landscape, Mechanical, Electrical, and Communications System Components.
- .2 The general arrangement of the file shall include:
 - .1 Cover sheet and table of contents;
 - .2 Folder for each Drawing series 100, 200, 300 etc. and folders for approved shop drawings and product data by specification section. Each section providing shop drawings shall contain a tab page;
 - .3 In each drawing series provide the As-Built Drawings and Autocad record drawings in pdf format;
 - .4 The approved shop drawing and product data and warranty folder shall:
 - .1 Include approved shop drawing log;
 - .2 Be organized by specification division and section number.
 - .5 The Building envelope and Structure shop drawings and product data file shall include but not be limited to: concrete reinforcing, structural steel and decking, steel staircases and ladders, structural precast concrete, trusses and joists, masonry mixes, masonry reinforcement, metal fabrications, cladding and insulation, roofing, windows, doors and hardware, flooring, millwork, firestopping, sealants, paints, paint colour information, test, inspection and deficiency reports.
 - .6 The static building mechanical , electrical and communications systems shop drawings and product data file shall include but not be limited to" plumbing pie and fittings, hangers and

- guides, floor and roof drains, insulation, power cable and wiring, power receptacles, switches, cable trays, racking systems, data outlets, test, inspection, deficiency and acceptance reports, TAB reports.
- .3 For As-Built Drawings recording field information, site instructions and change orders the drawings shall include but not be limited to the following content:
- .1 Field Information:
 - .1 Foundation depth including stepped footing locations;
 - .2 Structure reinforcement specified as a standard detail to be field located as directed;
 - .3 Deviations in piping and ductwork systems and communication conduit and cable tray routing;
 - .4 Valve tag numbers and function located on piping system drawings;
 - .2 Site Instructions and Change Orders:
 - .1 Dimensional and layout alterations;
 - .2 Material and construction type changes;
 - .3 Additional works added to the project;
 - .4 Works removed from the project.

1.6 Operations and Maintenance (O&M) Manual

- .1 O&M Manual shall be for operating systems with moving parts or safety systems requiring regularly scheduled inspection, maintenance or monitoring, typically but not restricted to operable walls , lockers, electric door operators, mechanical systems, electrical, automated control and alarm systems, elevators, rigging and anchorages.
- .2 The O&M Manual file folder structure shall include:
 - .1 Cover sheet and table of contents;
 - .2 Name, address and telephone number of General Contractor and all subcontractors;
 - .3 Folder for each Drawing series 100, 200, 300 etc. and folders for approved shop drawings and product data by specification section. Each section providing shop drawings shall contain a tab page;
 - .4 In each drawing series provide the As-Built Drawings and Autocad record drawings in pdf format;
 - .5 The approved shop drawing and product data and warranty folder shall:
 - .1 Include approved shop drawing log;
 - .2 Be organized by specification division and section number.
 - .6 Owners signed certificate that specified training has been provided and accepted.
 - .7 Reviewed shop drawings and product data sheets shall include but not be limited to:
 - .1 Motorized equipment, HVAC equipment, kitchen equipment, plumbing fixtures, pressure vessels, hydronic systems, high and low pressure steam systems, ductwork, dampers and louvers, sprinkler systems, control systems, electrical distribution system components, UPS systems, fire alarm systems, lighting, door operators, electrically operated partitions and screens, and anchor points for rigging, lifeline connectors, elevators and lifts;
 - .8 Schematics for HVAC systems, hydronic systems, steam systems, power distribution, and automated control systems.
 - .9 Automated control system sequence of operations;
 - .10 Manufacturer's published wiring, operating, maintenance and troubleshooting manuals;
 - .11 TAB report and testing, commissioning, inspection and deficiency reports.
 - .12 Inspection and manufacturer's warranty and guarantee certificates. Manufacturer's warranty and guarantee information shall include all pertinent contact information and clearly identify the starting date and duration of warranty period.
 - .13 List of spare parts and maintenance tools provided and copy of signed delivery receipts.

1.7 As-Built Drawings and Samples

- .1 Owner will supply a complete set of tender drawings including amendments drawings in hard copy and pdf format. The drawings are to be used as "As-Built Drawings" to record field information, site instructions and changes.
- .2 As-Built Drawings shall be kept on site at all times during construction without exception but are not to be taken to construction areas. Change orders and Site Instructions are to be kept in a binder with the As-Built Drawings.
- .3 Neatly record changes in permanent red fine line marker on the As-Built Drawings concurrently with the implementation.
- .4 Site Instruction number and Change Order number shall be annotated on the As-Built Drawings.

1.8 Spare Parts

- .1 Provide spare parts, in quantities specified in individual specification sections. Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work. If requested, furnish evidence as to type, source and quality of products provided.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Spare parts as identified in individual sections are to be delivered to the Owner prior to the Contractor's application for Substantial Performance.
- .4 Receive and catalogue items. Submit inventory listing to Consultant. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.
- .6 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.

1.9 Maintenance Materials

- .1 Provide maintenance and extra materials, in quantities specified in individual specification sections. Ensure maintenance materials provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work. If requested, furnish evidence as to type, source and quality of products provided.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Maintenance materials are to be delivered to the Owner prior to the Contractor's application for Substantial Performance.
- .4 Receive and catalogue items. Submit inventory listing to Consultant. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.
- .6 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.

1.10 Special Tools

- .1 Provide special tools, in quantities specified in individual specification sections. Ensure special tools provided are new, undamaged or defective, and of same quality and are provided or recommended by manufacturer of products provided in Work. If requested, furnish evidence as to type, source and quality of products provided.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Special tools are to be delivered to the Owner prior to the application for Substantial Performance.
- .4 Receive and catalogue items. Submit inventory listing to Consultant. Include approved listings in Maintenance Manual.
- .5 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.

1.11 Storage, Handling and Protection

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration. Store in original and undamaged condition with manufacturer's seal and labels intact.
- .2 Store components subject to damage from weather in weatherproof enclosures.
- .3 Store paints and freezable materials in a heated and ventilated room.
- .4 Remove and replace damaged products at own expense and to satisfaction of Consultant.

1.12 Warranty Manual

- .1 The Warranty Manual file folder structure shall be organized by specification division and section number and shall include:
 - .1 Cover sheet and table of contents;
 - .2 Name, address and telephone number of General Contractor and subcontractor;
 - .3 Folder for each Drawing series 100, 200, 300 etc. and;
 - .4 All pertinent contact information for the manufacturer and supplier;
 - .5 A duplicate copy of all manufacturer's warranties organized by specification section number.
- .2 Each section shall contain a tab page.
- .3 Separate each warranty or guarantee with index tab sheets keyed to Table of Contents listing.
- .4 Obtain warranties and guarantees, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of the applicable item of work.
- .5 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial Performance is determined.
- .6 Verify that documents are in proper form, contain full information, and are notarized.
- .7 Co-execute submittals when required.
- .8 Retain warranties and guarantees until time specified for submittal.

1.13 Final Survey

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

1.14 Independent Specialty Engineers Sign-Off

- .1 Prior to Substantial Performance, provide copies of signed and stamped engineers review and sign-off letters stating that the work has been built in accordance with their drawings and designs. Conditional or vague letters of sign-off will not be accepted. All specialty design engineers for all sub-contractors and suppliers will be required to review the work in progress at appropriate intervals to ensure compliance with their designs and drawings and shall provide final sign-off letters. Provide copies of all field reports issued by specialty engineers. Carry all costs associated with full compliance with this requirement.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not used

PART 3 EXECUTION

3.1 USB Flash Drive File Structure

- .1 General Layout:

- .1  Project Name
 - .1  GD Manual
 - .1  Cover Table of Contents
 - .2  Drawings
 - .1  Drawing List
 - .1.  100 Series
 - .2.  200 Series
 - .1  As Built/Record
 - .2  300 Series
 - i.  As Built/Record
 - .3  400 Series
 - i.  As Built/Record
 - .4  500 Series
 - i.  As Built/Record
 - .5  Etc.

- .2  Shop Drawings Product Data Warranty
 - .1.  Division xx
 - .1  Section xx xx xx
 - .2.  Division xx
 - .1  Section xx xx xx
 - .3.  Division xx
 - .4.  Etc.
 - .3  Inspection Reports
 - .1.  Materials Testing
 - .2.  Site Reports
 - .4  Independent Specialty Engineers sign-off
 - .5  Final survey drawing
-
- .2  O&M Manual
 - .1  Cover Table of Contents
 - .2  Drawings
 - .1  Drawing List
 - .2  100 Series
 - .1.  As Built
 - .2.  Record
 - .3  200 Series
 - .1.  As Built
 - .2.  Record
 - .4  300 Series
 - .1.  As Built
 - .2.  Record
 - .5  Etc.
 - .3  Shop Drawings Product Data Warranty
 - .1  Contents
 - .1.  Division xx
 - .2.  Section xx

- .3. Division xx
 - .4. Etc.
 - .2 TAB Inspection Reports
 - .1. Inspection Reports
 - .1 Materials Testing
 - .2 Site Reports
 - .3 Air Balancing
 - .4 Automated Control Systems Operation
 - .5 Etc.
 - .4 Spare Parts listing.
 - .5 Maintenance Materials listing.
 - .6 Special Tools listing.
 - .3 Warranty Manual
 - .1 Cover Table of Contents
 - .2 Contractors
 - .3 Warrantees and Guarantees
- 2 Typical shop drawing, product data and warranty folder contents in GD Manual
- .1 Section xx xx xx
 - .2 1 Section xx xx xx Tab page
 - .3 2 Shop Drawing x
 - .4 3 Warranty
- 3 Typical shop drawing, product data and warranty folder in O& M Manual
- .1 Section 25 xx xx
 - .2 1 Section x Tab page
 - .3 2 Shop Drawing x
 - .4 3 Operating Instructions x
 - .5 4 Maintenance Instructions x
 - .6 5 Warranty x
- .4 Specialty Engineer Sign Offs
- .5 Final Site Survey

- .6 USB flash drive file structure shall be edited to suit the project type.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 References

- .1 The National Building Code of Canada 2020, Part 8-Safety Measures on Construction and Demolition Sites.
- .2 CSA Group (CSA)
 - .1 CSA S350-M1980 (R2003) Code of Practice for Safety in Demolition of Structures
- .3 ASTM International (ASTM)
 - .1 ASTM F710-22 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
- .4 Ontario Provincial Regulations
 - .1 Ontario Regulation 102/94 Waste Audits and Waste Reduction Work Plans.
 - .2 Ontario Regulation 103/94 Environmental Protection Act.
 - .3 Ontario Regulation 213/07 The Fire Code.
 - .4 Ontario Regulation 232/98 Landfilling Sites.
 - .5 Ontario Regulation 278/05 Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations.
 - .6 Ontario Regulation 347 Environmental Protection Act, General — Waste Management.
 - .7 Ontario Regulation 332/12 The Building Code.
- .5 The Workplace Health and Safety Act, and Regulations for Construction Projects.
- .6 The Contractors Health and Safety Policy.
- .7 Laws, rules and regulations of other authorities having jurisdiction.

1.3 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit detailed written schedule, methodology and proposed procedures for demolition, including a Safe Work Plan for review prior to commencement of demolition.
- .3 Where required by authorities having jurisdiction, submit for approval drawings, diagrams or details clearly showing sequence of disassembly work or supporting structures and underpinning.
- .4 Drawings for structural elements of the demolition process including shoring, underpinning and installation of new lintels or beams in existing load bearing walls, shall bear signature and stamp of qualified professional engineer registered in the Province of Ontario.
- .5 Submit proposed dust-control measures.
- .6 Submit proposed noise-control measures.
- .7 Submit schedule of demolition activities indicating the following:
 - .1 Detailed sequence of demolition and removal work, including start and end dates for each activity.
 - .2 Dates for shutoff, capping, and continuation of utility services.
- .8 If hazardous materials are encountered and disposed of, landfill records indicating receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

- .9 At Project Closeout: Submit record drawings in accordance with Section 01 78 00. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions

1.4 Permits

- .1 Obtain and pay for all permits and comply with all laws, rules, ordinances, and regulations relating to Demolition of Building and preservation of Public Health and Safety.
- .2 The Consultant will complete General Review during demolition in accordance with the Ontario Building Code. All other engineering required for shoring design and for other structural elements of the demolition work will be completed by the Contractor's own engineer and paid for by the Contractor.

1.5 Waste Management Plan

- .1 All work of this section shall be completed in accordance with the contractors approved Waste Management Plan specified in Section 01 74 19.

1.6 Definitions

- .1 Chemical Waste: Includes petroleum products, bituminous materials, salts, acids, alkalis, herbicides, pesticides, organic chemicals and inorganic wastes.
- .2 Demolition Waste: Building materials and solid waste resulting from construction, remodeling, repair, cleanup, or demolition operations that are not hazardous. This term includes, but is not limited to, asphalt concrete, Portland cement concrete, brick, lumber, gypsum wallboard, cardboard and other associated packaging, roofing material, ceramic tile, carpeting, plastic pipe, and steel. The materials may include rock, soil, tree stumps, and other vegetative matter resulting from land clearing and landscaping for construction or land development projects.
- .3 Environmental Pollution and Damage: The presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human or animal life; affect other species of importance to humanity; or degrade the utility of the environment for aesthetic, cultural or historical purposes.
- .4 Inert Fill: A permitted facility that accepts inert waste such as asphalt and concrete exclusively for the purpose of disposal.
- .5 Inert Solids/Inert Waste: Non-liquid solid waste including, but not limited to, soil and concrete that does not contain hazardous substances or soluble pollutants at concentrations in excess of water-quality standards established by a regional water board and does not contain significant quantities of decomposable solid waste.
- .6 Landfill: A landfill that accepts non-hazardous materials such as household, commercial, and industrial waste, resulting from construction, remodeling, repair, and demolition operations. A landfill must have a solid waste facilities permit from the Ministry of the Environment and be in conformance to O. Reg 232/98.
- .7 Recycling: The process of sorting, cleansing, treating and reconstituting materials for the purpose of using the altered form in the manufacture of a new product. Recycling does not include burning, incinerating or thermally destroying solid waste.

- .8 Remove: Remove and legally dispose of items, except those identified for use in recycling, re-use, and salvage programs.
- .9 Reuse: The use, in the same or similar form as it was produced, of a material which might otherwise be discarded.
- .10 Solid Waste: All putrescible and non-putrescible solid, semisolid, and liquid wastes, including garbage, trash, refuse, paper, demolition and construction wastes, abandoned vehicles and parts thereof, discarded home and industrial appliances, dewatered, treated, or chemically fixed sewage sludge which is not hazardous waste, manure, vegetable or animal solid and semisolid wastes, and other discarded solid and semisolid wastes. "Solid waste" does not include hazardous waste, radioactive waste, or medical waste as defined or regulated by law.

1.7 Quality Assurance

- .1 Demolition Firm Qualifications: Demolition contractor shall be an experienced firm that has successfully completed demolition Work similar to that indicated for this Project.
- .2 Regulatory Requirements: Comply with governing regulations before starting demolition. Comply with hauling and disposal regulations of authorities having jurisdiction. Obtain and pay for all permits required.
- .3 Pre-demolition Conference: Conduct a conference at Project site.
 - .1 Review the environmental goals of this Project and make a proactive effort to increase awareness of these goals among all labor forces on site.
 - .2 Review schedule and scheduling procedures.
 - .3 Review health and safety procedures.
 - .4 Review of Project conditions including review of record photographs.

1.8 Project Conditions

- .1 Construct safety barriers, barricades, fencing and hoarding to separate public from work areas as described in Section 01 56 00.
- .2 The Owner assumes no responsibility for the actual condition of the structures to be demolished.
- .3 Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner insofar as practicable. Variations within the structures may occur by the Owner's salvage operations prior to start of demolition.

1.9 Designated Substances

- .1 Refer to Limited Designated Substances Survey Report, Brock High School Durham Regional Rd 12 Cannington, Ontario prepared by Maple Environmental INC. dated April 15, 2026
- .2 Should any other material not identified in the above referenced reports resembling asbestos or other hazardous substances be encountered in course of demolition work, immediately stop work and notify the Owner's Representative. Refer to Section 01 41 00.
- .3 All designated substances abatement, removal and disposal shall be completed in accordance with O. Reg 278/05 and all other applicable legislation.

PART 2 PRODUCTS

2.1 Materials

- .1 Provide all materials necessary for temporary shoring. On completion, remove temporary materials from site.
- .2 All building materials removed from the building shall become the property of the Contractor unless specified otherwise and shall be reused in new construction or removed from the Site.
- .3 All concrete, masonry, asphalt and similar materials shall be crushed prior to disposal.

2.2 Salvage

- .1 All items of salvageable value must be salvaged.
- .2 Provide a schedule of items to be salvaged and clearly indicate which items are to be retained by Owner. Clearly identify and tag each salvageable item.
- .3 Transport salvaged items from the site as they are removed.
- .4 Items of salvageable value to the Contractor may be removed from the structure as the work progresses, if such items are not claimed by the Owner.

2.3 Reuse

- .1 Salvage and reuse materials as indicated on the drawings.

2.4 Recycle

- .1 All materials from demolition and land clearing which can be recycled through local municipal programs and which is not scheduled for salvage shall be sorted and separated in accordance with Regional, Provincial and Municipal standards and regulations.
- .2 Provide recycling receptacles for the duration of construction activities at the building site.

PART 3 EXECUTION

3.1 Examination

- .1 Survey existing conditions and correlate with requirements indicated to determine extent of demolition, salvage and recycling required.
- .2 Verify that utilities have been disconnected and capped.
- .3 Survey condition of the building to determine whether removing any element might result in a structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during demolition.
- .4 Retain a licensed and qualified civil or structural engineer to provide analysis, including calculations, necessary to ensure the safe execution of the demolition work.

- .5 Perform surveys and tests as the Work progresses to detect hazards resulting from demolition activities.
- .6 Preliminary Survey:
 - .1 The Demolition Plans indicate the general extent of existing conditions based upon drawings provided by the Owner and existing site conditions. Review all areas of work to determine full extent of areas to be demolished, altered or renovated and become familiar with actual conditions and extent of work required.
 - .2 Before commencing demolition operations, examine Site and provide engineering survey to determine type of construction, condition of structure, and Site conditions. Assess strength and stability of damaged or deteriorated structures.
 - .3 Assess potential effect of removal of any part or parts on the remainder of structure before such part(s) are removed.
 - .4 Assess effects of demolition at adjacent structures and consider need for underpinning, shoring and/or bracing.
 - .5 Investigate for following conditions:
 - .1 load bearing walls and floors
 - .2 structure suspended from another
 - .3 effects of soils, water, lateral pressures on retaining or foundations walls
 - .4 presence of tanks and other piping systems
 - .5 presence of designated substances and hazardous materials.
- .7 After determining demolition methods, determine area of possible vibration. Carefully inspect beyond those adjacent areas. List potential damage areas and photograph each for record purposes before starting work.

3.2 Preparation

- .1 Erect and maintain dustproof and weatherproof partitions as required to prevent spread of dust, fumes and smoke to other parts of building. Maintain fire exits. On completion, remove partitions and make good surfaces to match adjacent surfaces of building.
- .2 Provide all shoring and bracing required for the execution of the work.
- .3 Ensure all sedimentation controls as required are in place prior to commencement of demolition activities.
- .4 Before commencing demolition, verify that existing water, gas, electrical and other services in areas being demolished are cut off, capped diverted or removed as required. Post warning signs on electrical lines and equipment which must remain energized to serve adjacent areas during period of demolition.
- .5 Conduct demolition operations and remove materials from demolition to ensure minimum interference with roads, streets, walks, and other adjacent occupied and utilized facilities.
- .6 Do not close or obstruct streets, walks, or other adjacent occupied or utilized facilities without permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

3.3 Utilities

- .1 Contact authorities or utility companies for assistance in locating and marking services passing under, through, overhead or adjacent to structure to be demolished. Such services include:

- .1 Electrical power lines
- .2 Gas mains
- .3 Communication cables
- .4 Fibre optic cables
- .5 Water lines.
- .6 Drainage piping (storm and sanitary).

- .2 Before disconnecting, removing, plugging or abandoning any existing utilities serving the building:
 - .1 Notify the Owner, applicable utility companies, and local authorities having jurisdiction.
 - .2 Cut off and cap utilities at the mains on the property or in the street as required by the Owner and responsible utility company. Maintain fire protection to the existing buildings at all times.
 - .3 Remove, cut off and plug, or cap all utilities within the existing building areas to be demolished, except those designated to remain

3.4 Protection

- .1 Erect and maintain temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction. Maintain such areas free of snow, ice, water and debris. Lighting levels shall be equal to that prior to erection.
- .2 Provide safe access and egress from working areas using entrances, hallways, stairways or ladder runs, protected to safeguard personnel using them from falling debris.
- .3 Do not interfere with use and activities of adjacent buildings and site. Maintain free and safe passage to and from buildings.
- .4 Where demolition operations prevent normal access to adjacent properties, provide and maintain suitable alternative access.
- .5 Provide flagmen where necessary or appropriate, to provide effective and safe access to site to vehicular traffic and protection to Owner's personnel. Refer to Division 1 for safety requirements.
- .6 Ensure that all necessary controls are in place at the beginning of each work period which will prevent the spread of contaminated material beyond the work area limits. Stop work immediately if there exists any possibility of the spread of contaminated materials.
- .7 Keep dust from entering existing facilities and areas of building not affected by the Work. Comply with Ministry of Health requirements regarding debris control.
- .8 Ensure scaffolds, ladders, equipment and other such equipment are not accessible to public. Protect with adequate fencing or remove and dismantle at end of each day or when no longer required.
- .9 Take precautions to guard against movement, settlement or collapse of adjacent structures, services or driveways. Be liable for such movement, settlement or collapse caused by failure to take necessary precautions. Repair promptly such damage when ordered.
- .10 If Owner considers additional bracing and shoring necessary to safeguard and prevent such movement or settlement, install bracing or shoring upon Owner's orders.
- .11 Particular attention shall be paid to prevention of fire and elimination of fire hazards which would endanger new work or existing premises.

- .12 Protect existing adjacent work against damages which might occur from falling debris or other causes due to work of this Section.
- .13 At all times protect the structure from overloading.
- .14 Provide protection around floor and/or roof openings.
- .15 Protect from weather, parts of adjoining structures not previously exposed.
- .16 Protect interiors of building parts not to be demolished from exterior elements at all times.
- .17 At end of each day's work, leave work in safe condition so that no part is in danger of toppling or falling.

3.5 Temporary Ventilation

- .1 Provide all required temporary ventilation for demolition work.

3.6 Environmental Controls

- .1 Comply with provincial and municipal regulations pertaining to water, air, solid waste, recycling, chemical waste, sanitary waste, sediment and noise pollution.
- .2 Dust Control, Air Pollution, and Odour Control: Prevent creation of dust, air pollution and odors.
 - .1 Use temporary enclosures and other appropriate methods to limit dust and dirt rising and scattering in air to lowest practical level.
 - .2 Store volatile liquids, including fuels and solvents, in closed containers.
 - .3 Properly maintain equipment to reduce gaseous pollutant emissions.
- .3 Noise Control: Perform demolition operations to minimize noise.
 - .1 Provide equipment, sound deadening devices, and take noise abatement measures that are necessary to comply with municipal regulations.
- .4 Salvage, Re-Use, and Recycling Procedures:
 - .1 Identify re-use, salvage, and recycling facilities.
 - .2 Develop and implement procedures to re-use, salvage, and recycle demolition materials.
 - .3 Identify materials that are feasible for salvage, determine requirements for site storage, and transportation of materials to a salvage facility.
 - .4 Source-separate clean and uncontaminated demolition materials including, but not limited to the following types:
 - .1 Concrete, Concrete Block, Concrete Masonry Units (CMU), Brick.
 - .2 Metal (ferrous and non-ferrous).
 - .3 Wood.
 - .4 Glass.
 - .5 Plastics and Insulation.
 - .6 Gypsum Board.
 - .7 Porcelain Plumbing Fixtures.
 - .8 Fluorescent Light Tubes.
 - .9 Paper: Bond, Newsprint, Cardboard, Paper, Packaging Materials.
 - .10 Other materials as appropriate.

3.7 Performance

- .1 Ensure demolition work is supervised by competent foreman at all times.
- .2 Demolition shall proceed safely in systematic manner. 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.
- .3 Until acceptance, maintain and preserve active utilities traversing premises.
- .4 Provide enclosed chutes for disposal of debris from heights more than 1 storey in accordance with CSA S350.
- .5 Maintain safety of site by shoring below-grade-structures and excavations resulting from demolition against collapse.

3.8 Demolition

- .1 Review demolition procedures to ensure no personnel or equipment are located or working without additional safe working platforms or working surface adequate to support the operations.
- .2 Any damage caused to the adjacent buildings or properties by the neglect of the Contractor or any of his forces shall be made good at the expense of the Contractor including all costs and charges which may be claimed by the Owner for damages suffered.
- .3 Demolish in a manner to minimize dusting. Keep dusty materials wetted at all times.
- .4 Demolition: Use methods required to complete Work within limitations of governing regulations and as follows:
 - .1 Locate demolition equipment throughout the building and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - .2 Demolish concrete and masonry in sizes that will be suitable for acceptance at recycling or disposal facilities.
 - .3 Break up and remove concrete slabs on grade in small sizes, suitable for acceptance at recycling or disposal facilities, unless otherwise shown to remain.
 - .4 Remove all finishes, fixtures, fitments and services as indicated
 - .5 Damages: Promptly repair damages to adjacent facilities caused by demolition operations.
 - .6 Prevent access to excavations by means of fences or hoardings.

3.9 Selective Demolition

- .1 Carefully dismantle and remove all items in as shown and as necessary to complete the work.
- .2 Salvage items scheduled for reuse or to be handed over to the Owner.
- .3 Particular attention shall be paid to prevention of fire and elimination of fire hazards which would endanger the existing buildings.
- .4 Where existing flooring is to be removed from floor slabs to remain, including ceramic tile flooring, carefully remove flooring, grout, adhesives, waterproofing membranes and the like down to the base slab. Patch and repair slab where damaged with concrete or acceptable leveling compound in accordance with new flooring manufacturer's instructions and ASTM F710. Refer to original

building drawings and remove and replace existing concrete floor toppings as necessary and where required.

- .5 Return areas to condition existing prior to the start of the work unless indicated otherwise.

3.10 Handling of Demolished Materials

- .1 Conform to the approved Waste Management Plan.
- .2 Do not allow demolished materials to accumulate or be stored on-site for more than 5 days.
- .3 Do not burn, bury or otherwise dispose of rubbish and waste materials on project site.
- .4 Pallet and shrink-wrap materials scheduled for re-use and stockpile where directed on site.
- .5 Disposal: Transport demolished materials off Owner's property and legally reuse, salvage, recycle, or dispose of materials. Legally transport and dispose of materials that cannot be delivered to a source separated or mixed recycling facility to a transfer station or disposal facility that can legally accept the materials for the purpose of disposal.
- .6 Deliver to facilities that can legally accept new construction, excavation and demolition materials for purpose of re-use, recycling, composting, or disposal.

3.11 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Clean adjacent streets and driveways of dust, dirt and materials caused by demolition operations.
- .3 Reinstate areas and existing works outside areas of demolition to conditions that existed prior to commencement of work.
- .4 Upon completion of demolition work, remove debris, trim surfaces and leave work site clean.
- .5 Video storm and sanitary sewers and jet clean where debris may have accumulated

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 03 20 00 Concrete Reinforcing
- .2 Section 03 30 00 Cast-in-Place Concrete
- .3 Section 05 50 00 Metal Fabrications

1.3 References

- .1 American Concrete Institute (ACI)
 - .1 ACI 117-10 Specifications for Tolerances for Concrete Construction and Materials.
 - .2 ACI 347R-14 Guide to Formwork for Concrete
 - .3 ACI SP-4-14 Formwork for Concrete
- .2 CSA Group (CSA)
 - .1 CSA A23.1:19/A23.2:19 Concrete Materials and Methods of Concrete Construction/ Methods of Test Methods and Standard Practice for Concrete
 - .2 CSA B111-1974 (R2003) Wire Nails, Spikes and Staples
 - .3 CSA O86:19 Engineering Design in Wood
 - .4 CSA O121-2017 (R2022) Douglas Fir Plywood
 - .5 CSA O141:23 Canadian Standard Lumber
 - .6 CSA S269.1-16 (R2021) Falsework and Formwork
- .3 Ontario Provincial Standard Specifications (OPSS)
 - .1 OPSS 1204 Material Specification for Polyvinyl Chloride Waterstops

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings showing type, extent and locations of items to be built into concrete.
 - .2 Sleeving Drawings: Submit drawings showing sleeves required through floors, roof and other structural members.
 - .3 Submit drawings showing size and spacing of conduits and piping.
 - .4 Coordinate with other Divisions prior to submittal.
 - .5 Do not commence placing sleeves, conduits, or piping before drawings have been reviewed and Consultant's comments incorporated on drawings issued to site.
 - .6 Assume responsibility for accuracy of Work. Review of submitted shop drawings does not relieve Contractor from compliance with requirements of Contract Documents.
- .3 Required by Regulatory Agencies: Submit shop drawings bearing signature and seal of Professional Engineer responsible for formwork design, as may be required by regulatory Agencies. Proceed with construction of formwork only with their approval.

1.5 Quality Assurance

- .1 Obtain a copy of CSA A23.1/A23.2 and maintain on site

- .2 Design of Formwork: Assume full responsibility for complete structural design and construction of formwork in accordance with CSA S269.1 and CSA O86, as applicable.
 - .1 The design and engineering of the formwork, as well as its' construction, shall be the responsibility of the Contractor.
- .3 Formwork shall be designed for the loads and lateral pressures outlined in the ACI publication "SP-4 Formwork for Concrete" and wind pressures and allowable stresses as set down in the National Building Code and in accordance with CSA A23.1 and A23.2. Formwork shall be of sufficient strength and rigidity to support all concrete and construction loads, taking into account proposed rate and method of pouring concrete so that the resultant finished concrete shall conform to the shapes, lines and dimensions of the members shown on the drawings.

1.6 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Protect formwork to prevent functional damage and damage to faces affecting appearance of concrete surfaces exposed to view.

1.7 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 All materials shall be new, in accordance with referenced standards.
- .2 Plywood: Douglas Fir, conforming to CSA O121. Sound undamaged sheets finished one side, fabricated especially for use as concrete form panels, with sealed edges. Minimum 17mm thickness.
- .3 Lumber: Conforming to CSA O141, with grade stamp clearly visible.
- .4 Chamfers: Cut from 19mm x 19mm wood, smooth with no open defects.
- .5 Form Ties: snap ties, with spreader washer and 25mm break back.
- .6 Joint Tape: non-staining, water impermeable, self-release.
- .7 Nails, Spikes and Staples: Galvanized, conforming to CSA B111.
- .8 Form Release Agent: Colourless mineral oil which will not stain concrete.
- .9 For concrete surfaces exposed to view, provide panels smooth and free of defects which would be reproduced as concrete blemishes.

PART 3 EXECUTION

3.1 Examination

- .1 Before starting this work, examine work done by others which affects this work.
- .2 Notify the Consultant of any conditions which would prevent proper completion of this work.
- .3 Commencement of work implies acceptance of existing conditions.

3.2 Erection

- .1 Verify lines, levels and centres before proceeding with formwork. Ensure dimensions agree with drawings.
- .2 Align joints and make watertight, to prevent leakage of cement paste and disfiguration of concrete.
- .3 Construct formwork to produce concrete with dimensions, lines and levels within tolerances specified in ACI 347R-14.
- .4 Provide formed openings where required for pipes, conduits, sleeves and other work to be embedded in and passing through concrete members.
- .5 Install chamfers at all external corners exposed to view.
- .6 Adequately brace and shore formwork to sustain loads (both concrete and working loads) applied during construction.
- .7 Be responsible for safety of the structure both before and after the removal of forms, until the concrete has reached its specified 28 day strength.

3.3 Built-In Work

- .1 Form openings and build in anchors, inserts, sub-frames, key-ways, sleeves, miscellaneous metal items, reglets and similar items furnished under Work of other Sections, which are indicated on Drawings and on shop drawings of other trades, and as required for proper completion of Work.
- .2 Do not embed wood in concrete.
- .3 Anchor Bolts: Tie anchor bolts securely in position to prevent movement during concrete placing. Use template to locate bolts. Verify that bolts have specified projection above concrete.
- .4 Openings or Sleeves Not Shown on Structural Drawings:
 - .1 Obtain Consultant's written approval before forming openings of sleeves through columns and beams, or through slabs within 1800 mm of their supports.
 - .2 Obtain Consultant's written approval before forming openings or sleeves larger than 200 mm square in any location.
- .5 Embedded Pipe or Conduit Not Shown or Detailed on Structural Drawings:
 - .1 Obtain Consultant's written approval before placing conduit or pipe which would be embedded in finished structure.
- .6 Confirm that built-in items that penetrate surface waterproofing are installed to meet requirements of waterproofing trade.

3.4 Construction Joints

- .1 Form construction and expansion joints with bulkheads to ensure straight lines. Immediately before subsequent pour at construction joint, remove bulkhead and tighten forms so that concrete surfaces will be on same plane with no overlapping of concrete.
- .2 Review with Consultant proposed location and details of construction joints in walls, columns, beams and slabs.
 - .1 Construction joints shall present appearance of normal form panel joint.
 - .2 Install continuous shear key in construction joints in walls and framed floors which are 152mm or more thick.
 - .3 Provide vertical construction joints in walls at not more than 20 metres centre to centre.
 - .4 Provide waterstops in accordance with manufacturer's instructions at construction joints in walls which retain earth. Waterstops shall be continuous.

3.5 Treatment of Formwork Surfaces

- .1 Form Release Agent:
 - .1 Coat formwork with form release agent before reinforcement, anchors, accessories, and other built in items are installed.
 - .2 Do not coat plywood forms pre-treated with release agent.
 - .3 On surfaces to receive finish materials, adhesives, sealers, paint or other coatings or materials, use a compatible release agent.

3.6 Stripping of Formwork

- .1 Strip formwork on vertical surfaces when concrete has hardened sufficiently that no damage will result from stripping operations.
- .2 Do not remove plywood formwork by jerking loose or by metal pinch bars. Use wood wedges and gradually force panels loose. Leave plywood forms in place as long as possible to permit maximum shrinkage away from concrete.
- .3 Take particular care not to damage external corners when stripping formwork.
- .4 When forms are stripped during curing period, cure and protect exposed concrete in accordance with Section 03 30 00 - Cast-in-Place Concrete.

3.7 Defective Work

- .1 Movement and displacement of formwork during construction, variations in excess of specified tolerances, marked and disfigured surfaces, and failure of materials or workmanship to meet requirements of this specification, and which cannot be repaired by approved methods, will be considered defective work.
- .2 Replace defective work, as directed by Consultant.
- .3 Pay for additional inspection and testing, redesign, corrective measures, and related expenses, if work has proven to be deficient.
- .4 Reconstruct defective formwork and replace concrete and reinforcement placed in defective formwork at no additional cost.

3.8 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 03 10 00 Concrete Forming and Accessories
- .2 Section 03 30 00 Cast-in-Place Concrete
- .3 Section 04 05 19 Masonry Anchorage and Reinforcing
- .4 Section 04 22 00 Concrete Unit Masonry
- .5 Section 05 50 00 Metal Fabrications

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM A143/A143M-07(2020) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
 - .2 ASTM A1064/A1064M-22 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- .2 American Concrete Institute (ACI)
 - .1 ACI SP-66 (04) ACI Detailing Manual
- .3 CSA Group (CSA)
 - .1 CSA A23.1:19/A23.2:19 Concrete Materials and Methods of Concrete Construction/ Methods of Test Methods and Standard Practice for Concrete
 - .2 CSA A23.3:19 Design of Concrete Structures
 - .3 CSA G30.18:21 Carbon Steel Bars for Concrete Reinforcement
 - .4 CSA G40.20-13/G40.21-13 (R2018) General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
 - .5 CSA W186:21 Welding of Reinforcing Bars in Reinforced Concrete Construction
- .4 Reinforcing Steel Institute of Canada (RSIC)
 - .1 RSIC Reinforcing Steel Manual of Standard Practice

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings, including placing drawings and bar lists.
 - .2 Prepare placing drawings and bar lists in accordance with the American Concrete Institute (ACI) Detailing Manual, and the Reinforcing Steel Institute of Canada (RSIC) Reinforcing Steel Manual of Standard Practice and the typical details included with Contract Documents.
 - .3 Prepare placing drawings to minimum scale of 1:50.
 - .4 Submit placing drawings and bar lists sufficiently detailed and dimensioned to permit correct placement of reinforcement and accessories without reference to architectural or structural Drawings.
 - .5 Show reinforcement, including dowels, in elevation on placing drawings for wall reinforcement.
 - .6 Show concrete cover to reinforcement.
 - .7 Show location of construction joints.
- .3 Inspection Reports: Inspection and Testing Company shall:
 - .1 Submit written reports of inspection and tests.
 - .2 Distribute reports as follows:
 - .1 Consultant.

.2 Contractor.

.4 Quality Assurance Submittals:

- .1 Mill Test Report: provide Consultant with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum 4 weeks prior to beginning reinforcing work.
- .2 Submit in writing proposed source of reinforcement material to be supplied.

1.5 Quality Assurance

- .1 Obtain a copy of CSA A23.1/A23.2 and maintain on site.
- .2 Qualifications: Welding: Undertake welding of reinforcement only by a fabricator or Subcontractor approved by Canadian Welding Bureau to requirements of CSA W186.
- .3 Source Quality Control: Source Quality Control may be performed by an Inspection and Testing Company appointed by Consultant.
- .4 Review provided by Inspection and Testing Company does not relieve Contractor of his sole responsibility for quality control over Work. Performance or non-performance of Inspection and Testing Company shall not limit, reduce, or relieve Contractor of his responsibilities in complying with the requirements of the Specification.
- .5 Identify and correlate reinforcing steel from Canadian mills with test reports for compliance with requirements specified.
- .6 Test unidentified reinforcing steel at expense of Contractor. Perform testing for each 1 tonne or part thereof supplied for incorporation in Work.

1.6 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

1.7 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 In accordance with reference standards.
- .2 Substitute different size bars only if permitted in writing by Consultant.
- .3 Bar Reinforcing Steel:
 - .1 Bars which are to be welded by arc-welding process: to CSA G30.18, Grade 400W.
 - .2 Other bars: to CSA G30.18, Grade 400R.
- .4 Plain round bars: to CSA G40.20-04/G40.21.
- .5 Welded Wire Fabric: to ASTM A1064/A1064M and in flat sheets, not rolls.
- .6 Cold-drawn annealed steel wire ties: to ASTM A497.

- .7 Chairs, bolsters, bar supports, spacers: to CSA A23.1.
- .8 Mechanical splices: subject to approval of Consultant.

2.2 Fabrication

- .1 Fabricate reinforcing steel only in permanent fabricating shop.
- .2 Fabricate reinforcing steel in accordance with shop drawings.
- .3 Tag reinforcing bars to indicate placement as designated on shop drawings.
- .4 Splices:
 - .1 Provide splices only where specifically indicated on Drawings.
 - .2 Stagger alternate mechanical splices 750 mm apart.
 - .3 Stagger alternate end bearing splices 750 mm apart.
 - .4 Install on threaded splices, plastic internal coupler thread protector and plastic bar end thread protector.

PART 3 EXECUTION

3.1 Examination

- .1 Before starting this work, examine work done by others which affects this work.
- .2 Examine formwork to verify that it has been completed, and adequately braced in place.
- .3 Notify the Consultant of any conditions which would prejudice proper completion of this work.
- .4 Commencement of work implies acceptance of existing conditions.

3.2 Installation

- .1 Place reinforcing steel in accordance with reviewed placing drawings, typical details, and CSA A23.3.
- .2 Adequately support reinforcing and secure against displacement within tolerances permitted.
- .3 Place reinforcing steel to provide minimum spacing and proper concrete cover as noted on drawings.
- .4 Do not cut reinforcement to incorporate other Work.
- .5 Relocate or rebend bars only on written instructions of Consultant.
- .6 Tie reinforcement in place. Do not weld.

3.3 Adjusting

- .1 Adjust and secure reinforcement in correct position immediately before concrete is placed.
- .2 Remove contaminants which lessen bond between concrete and reinforcement.

3.4 Field Quality Control

- .1 Provide competent supervisor, with at least three years of experience in reinforcement placement, to direct placement of reinforcement.
- .2 Inspect placement of reinforcement for conformance with Drawings and Specifications, before each concrete placement, and correct as necessary.
- .3 Consultant's periodic review of selected areas of reinforcement are for verification of conformity to design concept and general arrangement only and shall not relieve Contractor of responsibility for quality control, errors, or omissions, or conformance with requirements of Contract Documents.

3.5 Defective Work

- .1 Incorrectly fabricated, misplaced or omitted reinforcement will be considered defective Work.
- .2 Replace or adjust defective reinforcement before concrete is placed as directed by Consultant.
- .3 Replace or strengthen concrete work which is deficient as a result of incorrectly fabricated, misplaced, or omitted reinforcement, which was not corrected before concrete was placed.
- .4 Pay for additional inspection and testing, redesign, corrective measures, and related expenses, if Work has proven to be deficient.

3.6 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 03 10 00 Concrete Forming and Accessories
- .2 Section 03 20 00 Concrete Reinforcing
- .3 Section 04 05 19 Masonry Anchorage and Reinforcing
- .4 Section 04 22 00 Concrete Unit Masonry

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM C260/C260M-10a (2016) Standard Specification for Air Entraining Admixtures for Concrete
 - .2 ASTM C295/C295M-19 Standard Guide for Petrographic Examination of Aggregates for Concrete
 - .3 ASTM C309-19 Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete
 - .4 ASTM C330/C330M-17a Standard Specification for Lightweight Aggregates for Structural Concrete
 - .5 ASTM C494/C494M-19 Standard Specification for Chemical Admixtures for Concrete
 - .6 ASTM C881/C881M-20a Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 - .7 ASTM C1017/C1017M-13e1 Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
 - .8 ASTM C1107/C1107M-20 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
 - .9 ASTM D412-16 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
 - .10 ASTM D570-98(2018) Standard Test Method for Water Absorption of Plastics
 - .11 ASTM D624-00(2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
 - .12 ASTM D638-14 Standard Test Method for Tensile Properties of Plastics
 - .13 ASTM D1259-06(2018) Standard Test Methods for Nonvolatile Content of Resin Solutions
 - .14 ASTM D1751-18 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
 - .15 ASTM D2240-15e1 Standard Test Method for Rubber Property—Durometer Hardness
 - .16 ASTM D5329-20 Standard Test Methods for Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphalt Pavements and Portland Cement Concrete Pavements
- .2 American Concrete Institute (ACI)
 - .1 ACI 117-10 Specifications for Tolerances for Concrete Construction and Materials.
 - .2 ACI 232.1R-12 Report on the Use of Raw or Processed Natural Pozzolans in Concrete
- .3 CSA Group (CSA)
 - .1 CSA A23.1:19/A23.2:19 Concrete Materials and Methods of Concrete Construction/ Methods of Test Methods and Standard Practice for Concrete.
 - .2 CSA A283:19 Qualification Code for Concrete Testing Laboratories.
 - .3 CSA A3000-18 Cementitious Materials Compendium
- .4 Ontario Provincial Standard Specifications (OPSS)
 - .1 OPSS 1010 Material Specification for Aggregates - Granular A, B, M and Select Subgrade Material.

- .2 OPSS 1212 Material Specification for Hot-Poured Rubberized Asphalt Joint Sealing Compound.
- .5 Government of Canada Treasury Board Secretariat (TBS)
 - .1 Standard on Embodied Carbon in Construction

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Samples: Submit for inspection, material samples of specified mix designs.
- .3 Concrete Mix Designs:
 - .1 Submit concrete mix designs for review. Specify intended use for each mix design.
 - .2 Review of mix design does not relieve Contractor from responsibility for compliance with Contract Documents.
 - .3 Provide certification that mix proportions selected will produce concrete of specified quality and yield and that strength will comply with CSA A23.1. Mix design shall be adjusted to prevent alkali aggregate reactivity problems.
 - .4 Provide certification that plant, equipment, and all materials to be used in concrete comply with the requirements of CSA A23.1.
 - .5 Submit written requests for use of admixtures not specified, for site mixing of concrete, and for use of bonding agents.
 - .6 Submit in writing, proposed method of in-situ strength testing.
- .4 Inspection Reports: Inspection and Testing Company shall:
 - .1 Submit written reports of inspection and tests.
 - .2 Distribute reports as follows:
 - .1 Consultant;
 - .2 Contractor.
 - .3 On concrete cylinder test reports, include:
 - .1 Specific location of concrete represented by sample
 - .2 Design strength.
 - .3 Unit weight of sample
 - .4 Class of exposure
 - .5 Aggregate size and mixtures incorporated
 - .6 Date, hour and temperature at time sample taken
 - .7 Percentage air content
 - .8 Test strength of cylinder
 - .9 Type of failure if test fails to meet specification.

1.5 Quality Assurance

- .1 Obtain a copy of CSA A23.1/A23.2 and maintain on site.
- .2 Pre-Construction Conference:
 - .1 At least 35 days prior to the start of concrete construction schedule, conduct a meeting to review proposed mix designs and to discuss detailed requirements of the proposed concrete operations. Review requirements for submittals, coordination, and availability of materials. Establish work progress and sequencing schedules and procedures for material testing, inspection and certifications.
- .3 Source Quality Control:
 - .1 Both source quality control, and field quality control specified in Article 1.5.4, may be performed by an Inspection and Testing Company retained by the Contractor.

- .2 Review provided by Inspection and Testing Company does not relieve the Contractor of his sole responsibility for quality control over Work. Performance or non- performance of Inspection and Testing Company shall not limit, reduce, or relieve Contractor of his responsibilities in complying with the requirements of the Specification.
- .3 Inspection and Testing Company shall be certified under CSA A283, Qualification Code for Concrete Testing Laboratories, for Category 1 Certification.
- .4 Payment for specified Work performed by Inspection and Testing Company will be made from Cash Allowance.
- .5 Payment for additional tests (including testing of structure and its performance and load testing) required by changes of materials or mix design requested by Contractor, and failure of completed Work to meet specified requirements, shall be made at Contractor's expense.
- .6 Perform Work of source quality control in accordance with CSA A23.2 and to include:
 - .1 Verification that ready-mix supplier is qualified to supply concrete in accordance with Specification.
 - .2 Review of proposed concrete mix designs.
 - .3 Sampling, inspection, and testing of materials as may be required.
- .4 Field Quality Control:
 - .1 Inspection and Testing Company, when appointed as specified for Source Quality Control, shall perform sampling, inspection and testing of concrete work at site.
 - .2 Perform sampling, inspection and testing in accordance with CSA A23.2, and to include:
 - .1 Making of standard slump tests.
 - .2 Obtaining of three standard specimens for strength tests from each 100 m of concrete, or fraction thereof, of each mix design of concrete placed in any one day. In addition, for slabs-on-grade, obtain beam specimens for determination of modulus of rupture.
 - .3 Verification that test specimens are stored within an enclosure, maintained at specified temperatures.
 - .4 Making compression tests of each set of three specimens, one at 7 days and two at 28 days; modulus of rupture tests at 90 days.
 - .5 Verification of air content of air-entrained concrete.
 - .1 For Class of exposure F-1, and C-2, test at frequency in accordance with CSA A23.1.
 - .2 Make first test before placing any concrete.
 - .3 After stable air content has been established, frequency of tests will be determined by Consultant.
 - .4 For other Classes of exposure, test at time of obtaining strength test specimens.
 - .3 Inspection for Tolerances:
 - .1 Confirm that concrete work meets specified tolerance requirements.
 - .2 Use the elevation survey records of elevations of finished concrete surfaces specified in Section 03 10 00 and this section as basis for judging compliance.
 - .3 Use approved aluminum straightedge to judge compliance with specified slab tolerances, except use dipstick equipment where F-number tolerance is specified.
 - .4 Slabs-on-Grade:
 - .1 Observe application of curing compound to sample slab, recording rate of application.
 - .2 Monitor on a random basis acceptable to the Consultant, that slab is being saw cut before slab temperature starts to fall.
 - .3 Qualifications: Floor finishing shall be undertaken only by contractors with at least 10 years of experience.
 - .4 Sample of Finish Flooring:
 - .1 Finish an area of floor slab where directed by Consultant to provide sample of finish for approval.
 - .2 Protect new sample area until finish is approved.

- .3 If liquid membrane curing compound is to be used on Project, determine and apply correct quantity required to meet rate of coverage recommended by manufacturer for measured test area.
- .4 Approved sample will provide standard by which subsequent finishing will be judged and will be incorporated into Work.

1.6 Tolerances

- .1 In accordance with ACI 117 and CSA A23.1.
- .2 Difference between elevation of high point and low point in specified area not to exceed:
 - .1 In any bay up to 100 m²: 12 mm.
 - .2 In any bay up to 400 m²: 25 mm.
- .3 Straightedge method: Finish floor slabs to meet following tolerances when measured at 72 +/- 12 hours after completion of floor finishing, before shores are removed from formed slabs, by placing a freestanding unlevelled straight edge anywhere on slab and allowing it to rest on two high points. Gap between straightedge placed on two high points and slab not to exceed:
 - .1 3 metre straightedge: 8 mm (Class A).
 - .2 2 metre straightedge: 4 mm.

1.7 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.

1.8 Job Conditions

- .1 Protect floor slabs, and concrete surfaces exposed to view or on which finishes are to be applied, from grease, oil, and other soil which will affect the appearance of the concrete, or impair the bond of finish material.
- .2 Environmental Conditions: In addition to Cold Weather and Hot Weather Requirements of CSA A23.1, the following shall apply to Work of this Section:
 - .1 Provide protection or heat, or both, so that temperature of concrete at surfaces is maintained at not less than 21 ° C for three days after placing, not less than 10 ° C for the next two days and above freezing for the next two days.
 - .2 Do not permit alternate freezing and thawing for fourteen days after placing.
 - .3 Vent exhaust gases from combustion type heaters to atmosphere outside protection enclosures.
 - .4 Provide protection to maintain concrete continuously moist during curing period.
 - .5 For field cured cylinders representing strength development of in-situ concrete, provide same specified hot and cold weather protection for storage of each concrete compression specimen as for concrete from which it was taken, until it is sent to testing laboratory.
 - .6 Do not place concrete during rain. Should rain commence during placing, cover freshly placed concrete.
 - .7 Do not place bonded toppings on rough slabs that are less than 15 ° C.
 - .8 Do not grout at ambient air temperatures or concrete surface temperatures less than 5 ° C, or when temperature is forecast to fall to less than 5 ° C within 24 hours of grouting.
 - .9 Do not apply sealants at ambient air temperatures or concrete surface temperatures less than 5 ° C.

1.9 Project Records

- .1 Maintain record of all concrete pour related to time, date, delivery slip serial number and location of each concrete pour and identify related test cylinders. Keep records on site until project is completed.
- .2 Delivery Records: File duplicate copies of concrete delivery slips on which shall be recorded: supplier, serial number of slip, date, truck number, contractor, Project, Class of exposure, cementing materials content, air content, volume in load, and time of first mixing of aggregate, cementing materials and water.
- .3 Record Drawings:
 - .1 Record on a set of Drawings:
 - .1 founding elevations of all footings
 - .2 variations of foundation Work from that indicated on Drawings.
 - .2 Make record drawings available for Consultant's inspection at all times.

1.10 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 To meet specified requirements of referenced Standards.
- .2 Cement:
 - .1 Portland Cement: to CSA A3000.
 - .2 Cementitious Hydraulic Slag: to ACI 232.1R
- .3 Fine Aggregate: For slabs-on-grade, fineness modulus of fine aggregate to be between 2.7 and 3.1.
- .4 Coarse Aggregates:
 - .1 20 mm to 5 mm (No. 4 sieve) except as specified below.
 - .2 For slabs-on-grade 125 mm and thicker: 40 mm to 5 mm (No. 4 sieve); combine at least two of the single sizes specified in Table 5 Group II of CSA A23.1, one of which is to be 40 mm, to obtain maximum bulk density (unit weight) and optimum grading, in accordance with an approved procedure.
 - .3 For slabs-on-grade: Abrasion loss not to exceed 35%. Petrographic number of aggregate not to exceed 125 when tested in accordance with ASTM C295.
- .5 Curing-Sealing Compound: Membrane curing-sealing compound formulated from chlorinated rubber resins, or acrylic emulsion, solvent free for use in occupied buildings, to ASTM C309, type 1.
 - .1 Basis-of-Design Product: Euclid Chemical Company; Diamond Clear 350 or a comparable product by one of the following:
 - .1 BASF Corporation - Construction Systems.
 - .2 Sika Corporation
 - .3 W.R. Meadows
- .6 Bonding Agent: To ASTM C881, 100% reactive, 2 component, low viscosity, high modulus bonding adhesive.

- .7 Saw Cut Filler: Semi-rigid epoxy or polyurea in accordance with ACI 302.1R for joint fillers used in control and construction joints.
 - .1 Basis of Design Euco 700 or Euco QWIKjoint UVR by Euclid Chemical.
- .8 Premoulded Joint Fillers: Bituminous impregnated fiber board: to ASTM D1751.
- .9 Sealant: Refer to Section 07 92 00 – Joint Sealants
- .10 Mechanical Anchors: 'Kwik' Bolts, 'Cinch' Anchors or Parabolts.

2.2 Concrete Mixes

- .1 Ready Mix, with 28 day compressive strength as indicated on Drawings.
- .2 Design concrete mix in conformance with CSA A23.1, Tables 1, 2, 5 (Alternative 1) and 17, and as follows. Provide concrete meeting water/cementing materials ratio and air content of Table 14 in accordance with Class of exposure specified in following sub-paragraphs, and minimum strength specified on Drawings. Note that concrete designed in accordance with water/cementing materials ratio of Table 14 may yield strength exceeding minimum strength specified on Drawings.
 - .1 Class of exposure C-2 with 25 percent Portland cement replaced with cementitious hydraulic slag: for pavements, sidewalks, curbs and gutters.
 - .2 Class of exposure F-2 with 25 percent Portland cement replaced with cementitious hydraulic slag: for grade beams, and for exposed exterior beams, columns, walls and slabs.
 - .3 Slabs-on-Grade:
 - .1 Use type 20 Portland cement, or replace 35 percent Portland cement with cementitious hydraulic slag.
 - .2 When mean daily temperature exceeds 25 ° C at time of placement, replace 25 percent of type 20 cement, or 50 percent of type 10 cement, with cementitious hydraulic slag.
 - .3 Use water/cementing materials ratio 0.45 maximum.
 - .4 Use aggregates specified in paragraphs 2.1.3.
 - .5 Cementing materials content 325 kg/m.
 - .6 Modulus of rupture 3.5 MPa average, 3.0 MPa minimum.
 - .7 Slump at delivery, before addition of superplasticizer, 50 mm; add superplasticizer, not water, to bring slump to level acceptable to floor finisher for placement.
 - .4 Interior Concrete, other than specified above, and not exposed to freezing and thawing or the application of deicing chemicals: select water/cementing materials ratio and cementing materials content on basis of strength, workability, and finishing requirements.
- .3 Submit evidence, and material samples, if requested, acceptable to the Inspection and Testing Company, to verify that the proposed concrete mix design will produce specified quality of concrete.
- .4 List all proposed admixtures in mix design submission. Do not change or add admixtures to approved design mixes without Consultants approval.
- .5 Concrete Weight: Air dry unit weight: minimum 2,300 kg/m; adjusted proportionally for maximum air content listed in CSA A23.1, Clause 15, Table 10.
- .6 Concrete supplier to provide documentation indicating the requirements of TBS Standard on Embodied Carbon in Construction have been met.

2.3 Admixtures

- .1 Chemical Admixture: To ASTM C494. Incorporate water-reducing admixture, type WN, in all concrete.
- .2 Air Entraining Agent: To ASTM C260. Incorporate air-entraining agent in addition to chemical admixture in concrete of relevant Class of exposure, in accordance with CSA A23.1, Clause 15, Table 10.
- .3 Chloride: Do not use calcium chloride or admixtures containing chloride in concrete.

2.4 Premixed Grout

- .1 Non-Shrink Metallic: Non-catalyzed metallic grout to ASTM C1107, Compressive strength at 28 days: 48 MPa.
- .2 Non-Shrink, Non Stain, Non-Metallic: to ASTM C1107. Compressive strength at 28 days: 59 MPa.
- .3 Flowable Grout: High-tolerance Non-shrink, Non-metallic shrinkage compensating grout to ASTM C1107. Compressive strength at 28 days: 59 MPa.

PART 3 EXECUTION

3.1 Examination

- .1 Before starting this work, examine work done by others which effects this work.
- .2 Notify Consultant of any condition which would prejudice proper completion of this work.
- .3 Confirm that surfaces on which concrete is to be placed are free of frost and water before placing.
- .4 Confirm that reinforcement, dowels, control joints, inserts and all other built in work are in place and secured.
- .5 Commencement of work implies acceptance of existing conditions.

3.2 Treatment of Formed Surfaces

- .1 Conform to the requirements of CSA A23.1, and as additionally specified herein.
- .2 Treat concrete surfaces which will be exposed or painted in the completed building to provide a "Smooth Rubbed Finish" in accordance with CSA A23.1, uniform in colour and texture.
- .3 Plugs at Recessed Ties:
 - .1 Clean tie holes to remove all foreign matter.
 - .2 Coat plugs by dipping in adhesive and insert in hole.
 - .3 Remove excess adhesive immediately with thinner which will not stain concrete, as recommended by manufacturer.
- .4 Obtain Consultant's approval of finished exposed concrete and grind or otherwise correct to the satisfaction of the Consultant.

3.3 Placing Concrete

- .1 Place concrete in accordance with requirements CSA A23.1/A23.2.
- .2 Notify Consultant and inspection and testing firm at least 24 hours prior to commencement of concrete placing operation and 24 hours before wall forms are closed in.
- .3 Obtain Geotechnical Engineer's confirmation that thickness, elevation and compaction of sub-grade meets specifications before placing concrete.
- .4 Do not place concrete in water or open frozen surfaces.
- .5 Remove contaminants which lessen concrete bond to reinforcement before concrete is placed.
- .6 Maintain accurate records of cast in place concrete items. Record date, location of pour, quantity, air temperature and test samples taken.
- .7 Ensure that reinforcement, inserts, embedded items, formed expansion joints and the like, are not disturbed during concrete placement.
- .8 Joint fillers:
 - .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by 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 thick joint filler to separate slabs-on-grade from vertical surfaces and extend joint filler from bottom of slab to within 12 mm of finished slab surface unless indicated otherwise.
- .9 Provide construction joint as indicated on the drawings. Ensure dowels are adequately anchored and placed at right angles to the joint before placing concrete.
- .10 Place floor slabs to depth indicated on the drawings with 25 MPa minimum concrete unless otherwise noted on drawings but consistent with minimum cement content specified for exposed floors in this specification.
- .11 Sloping Surfaces and Slabs: commence concrete placement at bottom of sloping surfaces.

3.4 Finishing Concrete

- .1 Perform finishing operations on plastic concrete surfaces in accordance with CSA A23.1, and as specified herein.
- .2 Refer to the drawings for floor finishes and coverings.
- .3 Screed the top of rough floor slabs to an even level or sloping surface at the proper elevation to receive the finish or topping specified on the drawings and in finish schedule.
- .4 Provide a smooth steel trowel finish on all areas scheduled to receive a covering, or painted finish.
- .5 Exposed Floor Surfaces: Provide hard, smooth, dense, steel troweled surface, free from blemishes, and of uniform appearance.

- .6 Non-slip Surfaces: Provide swirl trowel or broom finish of texture acceptable to Consultant.
- .7 Curb Edging: Finish external corners of curbs rounded and smooth.

3.5 Curing

- .1 Cure concrete in accordance with CSA A23.1.

3.6 Grouting

- .1 Mix prepackaged grout with water in accordance with manufacturer's printed instructions.
- .2 Dampen concrete surfaces immediately before installing grout.
- .3 Use non-shrink and shrinkage-compensating grouts only when grout will be contained against expansion and self-disintegration.
- .4 Slope grout beyond edge of plate at 45 degrees.
- .5 Provide same environmental protection and curing as specified for concrete.

3.7 Joint Sealant

- .1 Apply sealant specified in Section 07 92 00 to thoroughly dry surfaces only, at ambient air temperatures above 5 ° C.
- .2 Provide sealant on top of joint filler with a polyethylene bond breaker between joint filler and joint sealant applied in accordance with manufacturer's direction.
- .3 Confirm that preformed joint filler and backer rod are compatible with sealant.
- .4 Caulk joints in accordance with the following:
 - .1 Do not commence joint preparation until concrete is at least 28 days old.
 - .2 Thoroughly clean sides of joints with mason's router, or power saw, equipped with double blade where necessary to suit joint width.
 - .3 Blow clean with compressed air with oil trap on line, or vacuum clean.
 - .4 Install backer rod of diameter 25 percent greater than joint width, and type recommended by sealant manufacturer to be compatible with sealant. Locate backer rod to provide for sealant depth of one-half joint width, but not less than 12 mm.
 - .5 Prime joint if required, as recommended by sealant manufacturer.

3.8 Defective Work

- .1 Variations in excess of specified tolerances and marked and disfigured surfaces that cannot be repaired by approved methods will be considered defective work.
- .2 Replace or modify concrete that is out of place or does not conform to lines, detail or grade as directed by the Consultant.
- .3 Replace or repair defectively placed or finished concrete as directed by the Consultant.
- .4 Testing and Replacement of Deficient Concrete in Place:
 - .1 Pay for additional testing and related expenses if concrete has proven to be deficient.

- .2 Replace or strengthen deficient concrete work as directed by the Consultant, and pay for all testing and related expenses for replaced work until approved by the Consultant.

3.9 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Clear away from the building site excess and waste materials and debris resulting from Work of this Section.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 04 22 00 Concrete Unit Masonry
- .2 Section 04 27 00 Multiple Wythe Unit Masonry
- .3 Section 05 12 23 Structural Steel

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM A153/A153M-23 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- .2 CSA Group (CSA)
 - .1 CSA A23.1:19/A23.2:19 Concrete Materials and Methods of Concrete Construction / Test Methods and Standard Practices for Concrete.
 - .2 CSA S304-14 (R2019) Design of Masonry Structures.
 - .3 CAN/CSA A371-14 (R2019) Masonry Construction for Buildings.
 - .4 CSA G30.3-M1983 (R1998) Cold-Drawn Steel Wire for Concrete Reinforcement.
 - .5 CSA G30.18-09 (R2014) Carbon Steel Bars for Concrete Reinforcement
 - .6 CSA W186-M1990 (R2016) Welding of Reinforcing Bars in Reinforced Concrete Construction
- .3 American Concrete Institute (ACI)
 - .1 Detailing Manual
- .4 Reinforcing Steel Institute of Canada (RSIC)
 - .1 Reinforcing Steel Manual of Standard Practice

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit the following samples:
 - .1 Two of each type of masonry reinforcing and connector specified.
- .3 Product Data: Submit manufacturer's printed product literature, specifications and data sheets.
- .4 Shop Drawings:
 - .1 Submit shop drawings for all masonry reinforcing. Include placing drawings, bar lists and details. Indicate clearly reinforcing bar sizes, spacing, bending details, lap details, dowels to adjacent construction location and quantities of reinforcement and connectors.
 - .2 Prepare placing drawings and bar lists in accordance with the American Concrete Institute (ACI) Detailing Manual, and the Reinforcing Steel Institute of Canada (RSIC) Reinforcing Steel Manual of Standard Practice, the typical details included with Contract Documents.
 - .3 Prepare placing drawings to minimum scale of 1:50.
 - .4 Submit placing drawings and bar lists sufficiently detailed and dimensioned to permit correct placement of reinforcement and accessories without reference to architectural or structural Drawings.
 - .5 Show reinforcement, including dowels, in elevation on placing drawings for wall reinforcement.
 - .6 Show cover to reinforcement

- .7 Show location of construction joints.

1.5 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

1.6 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 All metal components: hot dipped zinc galvanized to CSA S304 unless otherwise indicated.
- .2 Bar Reinforcement: To CSA A371 and CSA G30.18, grade 400R, deformed billet steel bars.
- .3 Wire Reinforcement: To CSA A371 and CSA G30.3.
 - .1 Masonry Veneer Walls: To CSA A370, hot dipped galvanized to ASTM A153, Class B2, 4.76 mm wire diameter, to suit overall wall thickness. BL-42 Ladder Reinforcement and System 2000 Seismic Adjustable Tie by Blok-Lok Ltd.
 - .2 Interior walls: hot dipped galvanized to CSA S304
 - .1 4.76 mm wire diameter hot dipped galvanized to CSA S304 for interior bearing walls.
 - .2 3.66 mm wire diameter bright wire finish, standard duty for interior non-bearing walls and partitions
 - .3 Truss Type: Blok-Trus BL-30 by Blok-Lok Ltd. for non-vertically reinforced walls
 - .4 Ladder Type: Blok-Trus BL-10 by Blok-Lok Ltd. for vertically reinforced walls
- .4 Equivalent products as manufactured by the following manufacturer's may be used subject to submission and acceptance by the Consultant of technical data:
 - .1 Hohmann and Barnard Inc.
- .5 Epoxy Adhesive: Hilti HIT-HY 2270 Adhesive anchor.

2.2 Fabrication

- .1 Fabricate reinforcing in accordance with CSA A23.1 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Ontario.
- .2 Obtain Consultant's approval for locations of reinforcement splices other than shown on placing drawings.
- .3 Upon approval of Consultant, weld reinforcement in accordance with CSA W186.
- .4 Ship reinforcement clearly identified in accordance with drawings.

PART 3 EXECUTION

3.1 Installation

- .1 Install masonry reinforcement, connectors and anchors in accordance with CSA A371, CSA A23.1 and CSA S304 unless indicated otherwise.

3.2 Reinforcement

- .1 Unless otherwise noted, all masonry walls shall be reinforced with joint reinforcement.
- .2 Reinforcement shall be installed in the first and second bed joints, 200 mm apart immediately above lintels and below sill at openings, and in bed joints at 400 mm vertical intervals elsewhere. Reinforcement in the second bed joint above or below openings shall extend 600 mm beyond the jambs. All other reinforcement shall be continuous except that it shall not pass through vertical masonry control joints. Side rods shall be lapped at least 150 mm at splices.
- .3 Use prefabricated corner and tee sections for continuous reinforcement at corners and intersecting walls.
- .4 Vertical reinforcement shall have a minimum clearance of 13 mm from the masonry and not less than one bar diameter between bars.
- .5 All block cores containing vertical reinforcing and/or anchor bolts shall be solidly filled with non-shrink grout.
- .6 Place reinforcement and ties in grout spaces prior to grouting.
- .7 Cleanouts: Provide cleanouts in the bottom course of masonry for each grout pour when the grout pour height exceeds 1.5 m.
- .8 Construct cleanouts so that the space to be grouted can be cleaned and inspected. In solid grouted masonry, space cleanouts horizontally a maximum of 800 mm on center.
- .9 Construct cleanouts with an opening of sufficient size to permit removal of debris. The minimum opening dimension shall be 76 mm.
- .10 After cleaning, close cleanouts with closures braced to resist grout pressure.

3.3 Bonding and Tying

- .1 Bond walls of two or more wythes using seismic connectors and ladder type reinforcement in accordance with CSA S304, CSA A371 and as indicated.
- .2 Tie masonry veneer to backing in accordance with CSA S304, CSA A371 and as indicated.
- .3 Masonry ties shall be installed as per the requirements of CSA A371 with maximum spacing of 400 mm vertically and 400 mm horizontally.

3.4 Reinforced Lintels and Bond Beams

- .1 Reinforce masonry lintels and bond beams as indicated.

- .2 Place and grout reinforcement in accordance with CSA S304.

3.5 Metal Anchors

- .1 Do metal anchors as indicated.

3.6 Lateral Support and Anchorage

- .1 Do lateral support and anchorage in accordance with CSA S304 and as indicated.
- .2 Anchor new masonry to existing with steel dowels as indicated. Drill into existing masonry and set reinforcing bars in epoxy adhesive in accordance with manufacturer's instructions.

3.7 Control Joints

- .1 Terminate reinforcement 25 mm short of each side of control joints unless otherwise indicated.
- .2 Control joints shall be stepped to avoid cutting lintel beams. Under no circumstance shall the control joints be placed to compromise the bearing for the lintel.

3.8 Field Bending

- .1 Do not field bend reinforcement and connectors except where indicated or authorized by Consultant.
- .2 When field bending is authorized, bend without heat, applying a slow and steady pressure.
- .3 Replace bars and connectors which develop cracks or splits.

3.9 Field Touch Up

- .1 Touch up damaged and cut ends of galvanized reinforcement steel and connectors with compatible finish to provide continuous coating.

3.10 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 03 10 00 Concrete Forming and Accessories
- .2 Section 03 20 00 Concrete Reinforcing
- .3 Section 03 30 00 Cast-in-Place Concrete
- .4 Section 04 05 19 Masonry Anchorage and Reinforcing
- .5 Section 04 27 00 Multiple Wythe Unit Masonry
- .6 Section 05 12 23 Structural Steel
- .7 Section 05 50 00 Metal Fabrications

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM C90-22 Standard Specification for Loadbearing Concrete Masonry Units
 - .2 ASTM C129-22 Standard Specification for Nonloadbearing Concrete Masonry Units
 - .3 ASTM C150/C150M-22 Standard Specification for Portland Cement
 - .4 ASTM C207-18 Standard Specification for Hydrated Lime for Masonry Purposes.
 - .5 ASTM D2240-15(2021) Standard Test Method for Rubber Property—Durometer Hardness.
 - .6 ASTM D5249-10(2021) Standard Specification for Backer Material for Use with Cold and Hot Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints.
- .2 CSA Group (CSA)
 - .1 CSA A23.1-14/A23.2:19 Concrete Materials and Methods of Concrete Construction / Test Methods and Standard Practices for Concrete.
 - .2 CSA A165 Series-14 (R2019) CSA Standards on Concrete Masonry Units.
 - .3 CSA A179-14 (R2019) Mortar and Grout for Unit Masonry
 - .4 CSA A371-14 (R2019) Masonry Construction for Buildings.
 - .5 CSA S304-14 (R2019) Design of Masonry Structures.
- .3 Canadian Concrete Masonry Producers Association (CCMPA) Quality Assurance Program.

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Data: Submit manufacturer's printed product literature, specifications and data sheets
- .3 Submit the following samples:
 - .1 Two (2) of each type of concrete masonry units specified.
 - .2 Two (2) of each type of masonry accessory specified.
- .4 Submit shop drawings for all masonry reinforcing. Include placing drawings, bar lists and details. Indicate clearly reinforcing bar sizes, spacing, bending details, lap details, dowels to adjacent construction location and quantities of reinforcement and connectors.
- .5 Submit engineered temporary bracing design drawings for temporary support of masonry walls. Drawings shall be prepared by, and bear the seal of a Professional Engineer, licensed in the Province of Ontario.
- .6 Certificates: submit product certificates signed by manufacturer certifying materials comply with

specified performance characteristics and criteria and physical requirements.

- .7 Inspection Reports: Inspection and Testing Company shall submit reports of inspections and tests.
 - .1 Distribute inspection reports as follows:
 - .1 Consultant.
 - .2 Structural Engineer
 - .3 Contractor.

1.5 Quality Assurance

- .1 The masonry sub-contractor shall have a minimum of five years of continuous documented Canadian experience in work of the type and quality shown and specified. Proof of experience shall be submitted when requested by the Consultant and shall be subject to the approval of the Consultant.
- .2 Pre-installation meeting: conduct pre-installation meeting to verify project requirements manufacturer's instructions and manufacturer's warranty requirements.
- .3 Field Quality Control:
 - .1 Inspection and testing will be carried out by Testing Laboratory designated by Owner.
 - .2 Payment for specified Work performed by Inspection and Testing Company will be made from Cash Allowance.
 - .3 Inspection and Testing Company shall perform sampling, inspection and testing of masonry work at site, in accordance with referenced standards, including but not limited to the following:
 - .1 Masonry Placement Inspection
 - .2 Reinforcing Steel Placement
 - .3 Grout and Mortar Testing
 - .4 CMU Testing
 - .4 Review provided by Inspection and Testing Company does not relieve Contractor of his sole responsibility for quality control over Work. Performance or non-performance of Inspection and Testing Company shall not limit, reduce, or relieve Contractor of his responsibilities in complying with the requirements of the Specification.
 - .5 Provide access to Work for inspectors.

1.6 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.
- .3 Materials shall be kept clean and dry.
- .4 Deliver cement, lime and mortar ingredients with manufacturer's seal and labels intact.
- .5 Cementitious material and aggregates shall be stored in accordance with the requirements of CSA A23.1.
- .6 Exposed units which become stained or chipped, surface marked or scratched, and materials which are affected by inadequate protection shall be replaced, at no additional expense to the Owner.

1.7 Project Conditions

- .1 Provide heat enclosures and heat as required.
- .2 Work to be undertaken shall be carried out according to CAN3-A371, Clause 5.15.2.
- .3 Maintain temperature of mortar between 5 ° C and 50 ° C until batch is used.
- .4 Keep masonry dry using secure waterproof, non-staining coverings that extend over walls and down sides sufficient to protect walls from wind driven snow, rain and dirt, until masonry work is completed and protected by flashings or other permanent construction.
- .5 Protect masonry and other work from marking and other damage. Protect completed work from mortar droppings. Use non-staining coverings.

1.8 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 Masonry Units: Concrete Block: Modular, conforming to CCMPA requirements and CSA A165.1.
 - .1 H/20/A/M concrete masonry units to be used at all load bearing masonry walls.
 - .2 H/15/A/M concrete, masonry units, at all other locations unless noted otherwise.
 - .3 Refer to drawings for Fire Resistance Ratings. Type of concrete and block to conform to Table 5.0, Fire Resistance Rating of Concrete Block in Hours, of the Canadian Concrete Masonry Producers Association Handbook.
 - .4 Special shapes: provide special shapes indicated or required including bullnose and corner blocks, base blocks, fillers, and the like as may be required. Provide purpose made shapes for lintels and bond beams.
 - .5 Exposed block shall all be made by one manufacturer and shall be uniform in colour, shade and texture.
- .2 Bar Reinforcement, wire reinforcement, connectors and ties: as specified in Section 04 05 19 - Masonry Anchorage and Reinforcing.
- .3 Control Joint Filler: to ASTM D5249-10, Type 1, Round, flexible, continuous-length, nonabsorbent, nongassing, nonstaining, and nonshrinking. Extruded from a cross-linked polyethylene. Flexible foam, heat-Resistant Backer Rod. 9.5 mm thick by width of wall.
- .4 Pre-manufactured Masonry Control Joint: Pre-manufactured polyvinylchloride control joints may be used in lieu of the specified built-up type of joint.
- .5 Mortar: Conforming to CSA A179.
 - .1 Use same brand of material and source of aggregate for entire project.
 - .2 Aggregate: CSA A179, fine grain aggregates.
 - .3 Cement: normal Portland to ASTM C150, Type 10.
 - .4 Water shall be clean, potable and free of deleterious amounts of acid, alkalies, or organic materials.
 - .5 Hydrated Lime: Type 'S' to ASTM C207.
 - .6 Type 'S' mortar shall be used for all concrete block masonry work.

- .7 Proprietary Mortar Mixes: conform to mix requirements specified
- .8 Mortar colour for concrete unit masonry work shall be grey.
- .9 Admixtures of any kind are not allowed.

.6 Grout: to CSA A179, Table 3: Premixed, non-shrink non-metallic grout.

.7 Other materials not specifically described but required for a complete and proper installation of masonry, shall be as selected by the Contractor subject to approval by the Consultant

2.2 Mixes

- .1 Mixing: Prepare and mix mortar materials under strict supervision, and in small batches only for immediate use.
- .2 Mix proprietary mortars in strict accordance with manufacturer's instructions to produce the specified mortar types in accordance with CSA A179. Do not use re-tempered mortars.
- .3 Take representative samples for testing consistency of strength and colour according to CSA A179.

2.3 Accessories

- .1 Mechanical Fasteners: As recommended by manufacturer of material to be fastened, and in accordance with the reference standards, corrosion resistant.

PART 3 EXECUTION

3.1 Examination

- .1 Examine work of other trades for defects or discrepancies and report same in writing to Consultant.
- .2 Installation of any part of this work shall constitute acceptance of such surfaces as being satisfactory.

3.2 General

- .1 Do masonry work in accordance with CSA A371 except where specified otherwise.
- .2 A competent masonry foreman shall supervise and direct the work and only skilled masons shall execute the work of this Section.
- .3 Coordinate work of this Section with others such as, field welding of anchors to steel work, insulation application, and the like. Prepare all items for built-in as the work proceeds, either supplied and installed by other trades or installed under this Section.
- .4 Unless otherwise indicated on the drawings, all interior masonry partitions shall extend from floor level to the underside of floor or roof structures above.

3.3 Installation

- .1 Build masonry plumb, level, and true to line, with vertical joints in alignment.

- .2 Lay out coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings, with minimum of cutting.
- .3 Lay block with webs to align plumb over each other with thick ends of webs up. The top course of all partitions which do not pass through a ceiling or up to the underside of a roof deck shall have the open cells filled solid.
- .4 Cut exposed block with power driven abrasive cutting disc or diamond cutting wheel for flush mounted electrical outlets, grilles, pipes, conduits, leaving 3 mm maximum clearance.
- .5 Fill all vertical and bed joints, including plain end faces, through the entire wall thickness solidly with mortar.
- .6 Do not break bond of exposed walls where partitions intersect and if bond would show through on exposed face of walls. Bond these partitions to walls they intersect with prefabricated intersection masonry reinforcement in each course.
- .7 Bond intersecting block walls in alternate courses.
- .8 Terminate non load bearing walls within 20 mm of structure above unless indicated otherwise.
- .9 Where walls are pierced by structural members, ducts, pipes, fill voids with mortar to within 20 mm of such members.
- .10 Buttering corners of units, throwing mortar droppings into joints, deep or excessive furrowing of bed joints, is not permitted. Do not shift or tap units after mortar has taken initial set. Where adjustment must be made after mortar has started to set, remove mortar and replace with fresh supply.
- .11 Do not wet concrete masonry before or during laying in wall.
- .12 Bed and vertical joints shall be evenly and solidly filled with mortar.
- .13 Provide reinforced bond beams where indicated on structural drawings.
- .14 Provide vertical reinforcement as indicated on structural drawings. Fill all reinforced cores solid with grout as indicated. Provide cleanout port at bottom of each grouted core when required by Consultant.

3.4 Exposed Masonry

- .1 Do not use chipped, cracked or stained, and otherwise damaged units or unsatisfactory material in exposed and load bearing masonry walls.
- .2 Lay all joints 10 mm thick (uniform). All joints shall be full of mortar except where specifically designated to be left open.
- .3 All joints shall be slightly concave. Use sufficient force to press mortar tight against masonry units on both sides of joints. Remove excess material or burrs left after jointing by means of a trowel or rubbing with burlap bag.
- .4 Provide bullnose block at all exposed masonry corners.

3.5 Tolerances

- .1 Tolerances in notes to Clause 5.3 of CSA A371 apply.

3.6 Reinforcement

- .1 Refer to Section 04 05 19 - Masonry Anchorage and Reinforcing.

3.7 Loose Steel Lintels

- .1 Install loose steel lintels. Centre over opening width.
- .2 Lintels supplied under Section 05 50 00 – Metal Fabrications.

3.8 Control Joints

- .1 Provide continuous joints as indicated and at spacing not to exceed 6000 mm c/c unless noted otherwise on drawings.
- .2 Break vertical mortar bond with extruded neoprene gasket or building paper.
- .3 Prime control joint to prevent drying out of caulking material.

3.9 Support of Loads

- .1 Use 25 MPa concrete unless specified otherwise on the Drawings, where concrete fill is used in lieu of solid units.
- .2 Use grout to CSA A179 where grout is used in lieu of solid units.
- .3 Install building paper below voids to be filled with grout. Keep paper 25 mm back from face of units.

3.10 Lateral Support and Anchorage

- .1 Do lateral support and anchorage of masonry in accordance with CSA S304.1 and as indicated.

3.11 Grouting

- .1 Grout masonry in accordance with CSA S304.1 and as indicated.

3.12 Temporary Wall Bracing

- .1 Design and provide all required temporary engineered wall bracing.
- .2 Brace masonry walls to resist wind pressure and other lateral loads during construction period.
- .3 Provide temporary bracing of masonry work during and after erection until mortar has cured and permanent lateral support is in place

3.13 Built-ins

- .1 Build in items required to be built into masonry and provided by other Sections, including bearing plates, door frames, anchor bolts, sleeves and inserts. Build in items to present a neat, rigid, true and plumb installation. Leave wall openings required for ducts, grilles, pipes and other items.
- .2 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as work progresses.
- .3 Brace door jambs to maintain plumb. Fill voids between masonry and metal frames with masonry mortar or insulation, as indicated on drawings or as required to provide a neat, finished appearance.
- .4 Set wall plates on masonry in non-shrink grout in accordance with manufacturer's instructions.
- .5 Do all cutting, fitting, drilling, patching and making good for other trades in masonry work.

3.14 Protection

- .1 Protect masonry units from damage resulting from subsequent construction operations.
- .2 Use protection materials and methods which will not stain or damage masonry units.
- .3 Remove protection materials upon Substantial Performance, or when risk of damage is no longer present.

3.15 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Allow mortar droppings on unglazed concrete masonry to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of block and finally by brushing.
- .3 Remove mortar from concrete floor slabs and leave entire area vacuum clean.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 03 30 00 Cast-in-Place Concrete
- .2 Section 04 22 00 Concrete Unit Masonry
- .3 Section 05 50 00 Metal Fabrications

1.3 References

- .1 ASTM International, (ASTM)
 - .1 ASTM A108-18 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
 - .2 ASTM A123/A123M-17 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - .3 ASTM A153/A153M-23 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - .4 ASTM A307-21 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
 - .5 ASTM A653/A653M-23 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - .6 ASTM A1011/A1011M-23 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 - .7 ASTM F3125/F3125M-22 Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
- .2 CSA Group (CSA)
 - .1 CSA G40.20/G40.21-13 (R2018) General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
 - .2 CSA G164-18 Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .3 CSA S16:19 Design of Steel Structures.
 - .4 CSA S136-16 North American Specification for the Design of Cold Formed Steel Structural Members
 - .5 CSA W47.1:19 Certification of Companies for Fusion Welding of Steel Structures.
 - .6 CSA-W48.1-M1991 (R1998) Carbon Steel Covered Electrodes for Shielded Metal Arc Welding
 - .7 CSA-W55.3-08 (R2013) Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.
 - .8 CSA W59-18 Welded Steel Construction (Metal Arc Welding).
 - .9 CSA W178.1-18 Certification of Welding Inspection Organizations.
 - .10 CSA W178.2-18 Certification of Welding Inspectors.
- .3 American Welding Society (AWS)
 - .1 AWS A2.4:2020 Standard Symbols for Welding, Brazing, and Nondestructive Examination
- .4 Structural Steel Painting Council
 - .1 SSPC-SP 6-91 Commercial Blast Cleaning.
- .5 Canadian Institute of Steel Construction (CISC)/Canadian Paint Manufacturer's Association (CPMA)
 - .1 CISC/CPMA 1-73a Quick-Drying, One-Coat Paint for Use on Structural Steel.

- .6 American Institute of Steel Construction (AISC)
 - .1 Code of Standard Practice for Steel Buildings and Bridges, Section 10, Architectural Exposed Structural Steel, latest edition.
- .7 The National Building Code of Canada.

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit shop and erection drawings. Submit typical details of connections and any special connections for review before preparation of shop drawings. Assume responsibility for the accuracy of Work. Review of submitted shop drawings is to ensure only that the Contract Documents are being correctly interpreted.
- .3 Professional Engineer responsible for connection design shall sign and seal each shop drawing.
- .4 Show on shop drawings the size, spacing, and the location of structural steel members; connections; attachments; reinforcing; anchorage and required inserts; and all necessary plans, elevations and details.
- .5 Show splice locations and details.
- .6 Welded connections shall be designated by welding symbols in compliance with AWS A2.4:2020 and indicate clearly net weld lengths.
- .7 Submit design calculations if requested by the Consultant.
- .8 Submit diagrams showing methods of erection.
- .9 Field Work Drawings shall be submitted as shop drawings.
- .10 Notify Consultant in writing of any deviations in shop drawings from the requirements of the Contract Documents.
- .11 Submit a schedule of fabrication to the Consultant and the Testing Agency, prior to commencement of fabrication.

1.5 Qualifications

- .1 Undertake welding and/or welding inspection by welders fully approved to one or more of the reference codes and standards where applicable.

1.6 Quality Assurance

- .1 Connections:
 - .1 Connections designed by Engineer: Submission of shop drawings for connection which have been detailed on Drawings shall represent acceptance by Contractor that connection can be executed successfully.
 - .2 Design of other connections which cannot be selected from standard designs tabulated in CISC Handbook of Steel Construction shall be by a Professional Engineer, licensed in the Province of Ontario, experienced in structural steel connection design.
 - .3 Consultant will review connection arrangement to verify general conformance with overall design concept of structure.

- .4 Connection design engineer shall be insured for 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.
- .5 Provide connections adequate to resist reaction of beam, when beam is loaded to maximum flexural capacity under uniformly distributed load, unless reaction or connection detail is shown on Drawings.
 - .1 Provide flexible beam connections for unrestrained members in accordance with CSA S16.1, unless shown otherwise on Drawings.
 - .2 Select connections, wherever possible, from standard designs tabulated in current edition of CISC Handbook of Steel Construction, except that length of beam web angles shall not be less than half the depth of beam, and single angles shall not be used.
 - .3 Provide direct connections to flanges of spandrel beams (exterior perimeter beams) to restrain twisting.
- .2 Design:
 - .1 Connections:
 - .1 Provide bolted or welded connections, unless shown otherwise on Drawings.
 - .2 Use high strength bolts to ASTM F3125 for all connections.
 - .3 Use slip resistant (friction-type) connections for bolted joints designed to resist reversible forces.
 - .4 Provide tension adjustment hardware at rod type bracing and at flat bar type bracing.
 - .5 Do not permit connections to encroach on clearance lines required for installation of Work of other Sections.
 - .3 Random Splicing: Obtain in writing from Consultant, prior to commencement of shop drawings, special requirements that will be imposed as a necessary condition of acceptance of members with randomly located butt welded splices.
 - .4 All edge perimeter angles and bent plates installed at roof framing level shall be joined by butt weld splices designed for full tension capacity of members being joined.
- 1.7 Tolerances
 - .1 In addition to tolerances specified in CSA S16, erect shelf angles and sash angles attached to steel frame within a tolerance of 3 mm plus or minus, with abutting ends of members at the same level.
- 1.8 Inspection and Testing
 - .1 Refer to Section 01 45 00 – Quality Control.
 - .2 Inspection and testing of materials and shop fabrication of Work of this Section, and field quality control, will be performed by an independent Inspection and Testing Company. Refer to Section 01 45 00 - Quality Control.
 - .3 The Inspection and Testing Company shall meet qualification requirements of CSA W178.1 and shall be certified by the Canadian Welding Bureau in Category 1 Buildings.
 - .4 Welding Inspectors and supervisors shall be certified by Canadian Welding Bureau to CSA W178.2, to minimum level 2 certification.
 - .5 Provide free access for inspectors to all places work is being performed, whether on site or off.

- .6 Mill inspection shall ensure that materials conform to specified requirements. Mill test reports, properly correlated to the materials, will be accepted in lieu of physical tests.
 - .7 Shop inspection shall ensure that structural steel is fabricated in accordance with the shop drawings, and the specified fabrication and welding procedures.
 - .8 The cost of inspection and testing of splices introduced by the fabricator and not required on the Contract Documents will be paid by the Contractor.
 - .9 Inspection and Testing Company when appointed shall carry out shop inspection to verify:
 - .1 Structural materials and paint conform to Specifications. Mill test reports, properly correlated to the materials, will be accepted in lieu of physical tests of structural materials.
 - .2 Fabrication and welding conforms to Specifications and dimensioned shop drawings.
 - .3 Shop cleaning and preparation and prime painting to conform to specified requirements.
 - .4 Surfaces inaccessible for cleaning and painting after assembly are treated before assembly.
 - .5 For surfaces painted with zinc rich paint or zinc primer, specified surface preparation is followed and specified paint thickness is applied.
 - .10 Non-destructive Testing of Welded Connections: Carry out non-destructive testing of welded connections chosen at random as follows:
 - .1 Check and record steel member sizes for 20% of columns, beams and girders.
 - .2 Check 5% of all welds by magnetic particle inspection.
 - .3 Check 25% of moment connections and all connections subject to direct tension involving use of full penetration groove welds by ultrasonic testing.
 - .4 Check 10% (minimum 2 per connection) in accordance with Section 23 of CSA S16 of pretensioned connections including main building bracing connections.
 - .11 More frequent testing and inspection shall be completed if random tests described above are not satisfactory. These costs are to be paid by the Contractor.
- 1.9 Shipping, Handling and Storage
- .1 Refer to Section 01 61 00 – Common Product Requirements.
 - .2 Deliver products that are only supplied under work of this Section to those who are responsible for their installation, to the work site as directed and to meet construction schedule.
 - .3 Handle and store structural steel in such a manner that no damage, including corrosion, is caused to the stored or erected work, or to other property.
 - .4 Store structural steel off of ground on timber supports.
- 1.10 Waste Management and Disposal
- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 Rolled shapes, hollow structural sections, plates and rods: new steel, in compliance with CSA and/or ASTM Standards indicated on Structural Drawings.

- .2 Welding Electrodes: to meet the requirements set forth in the applicable standard of the CSA W48 Series on welding electrodes. (Any process which produces deposited weld metal meeting the requirements of the applicable W48 Series Standard for any grade of arc welding electrodes shall be accepted as equivalent to the use of such electrodes.)
- .3 High Strength Bolts: to meet specified requirements of ASTM F3125
- .4 Anchor Bolts: To CSA-G40.20/G40.21, Grade 300W.
- .5 Shop Coat Paint:
 - .1 Interior structural steel: To meet specified requirements of CISC/CPMA 1-73a and compatible with Master Painters Institute INT 5.1S or 5.1X Institutional low odour/low VOC semi-gloss finish. Colour to be grey.

PART 3 EXECUTION

3.1 Fabrication

- .1 Fabricate work of this Section in compliance with CSA S16, and as specified following.
- .2 Connections:
 - .1 Make bolted or welded connections.
 - .2 Use high strength bolts unless otherwise noted on Drawings.
 - .3 Use friction type high strength bolts for the connections of bracing members (diagonal kickers) resisting the effects of applied lateral loads. Provide tension adjustment at flat bar and rod type lateral bracing.
 - .4 Do not permit connections to encroach on the clearance lines required for the installation of work of this Section.
- .3 Beam Connections:
 - .1 Provide beam connections adequate to resist the reactions produced by the framing or load conditions.
 - .2 Provide beam to column connections that apply vertical reaction with negligible eccentricity at the connecting face of the column, such as single or double beam web connections, end plate connections or un-stiffened seats, unless otherwise shown on Drawings. Submit for review, in advance of the preparation of shop drawings, connections which do not meet these requirements.
 - .3 Provide connections complying with the requirements of the CISC Handbook of Steel Construction, except that the length of beam web angles shall not be less than half the depth of the beam and single angles shall not be used.
 - .4 Provide direct connections to flanges of spandrel beams to restrain twisting.
- .4 Holes in Structural Members:
 - .1 Punch holes 11 mm to 27 mm in diameter as required for attaching the work of other Sections to structural steel members. Locate holes so that no appreciable reduction of the strength of members is caused.
 - .2 Provide holes for pipes and ducts, and reinforce openings as indicated on drawings. Cutting of holes in structural members in the field will not be permitted except with written approval of the Consultant.
 - .3 Provide effective drainage holes to prevent the accumulation of water in tubular members.
- .5 Member Separators: Provide separators at approximate spacing of 1200 mm o.c. for double beams and channels as follows:

- .1 For beams and channels 225 mm or less in depth: one or two rows of pipe separators.
- .2 For beams and channels over 225 mm in depth: channel separators, unless otherwise detailed on Drawings.
- .6 Built up Compression Members General Requirements: Comply with the requirements of CSA-S16, for all built up compression members.
- .7 Column Bearing Plates: Mill column bearing plates under column bearing unless plate is sufficiently flat to give adequate contact bearing between column and plate.
- .8 Structural Steel Painting: All prime painting shall be shop applied and the responsibility of the steel fabricator. Refer to specific priming requirements specified in Section 09 91 23 - Interior Painting.
 - .1 Paint in accordance with manufacturer's published directions. Paint steel in the shop under cover. Keep painted members under cover until the paint has dried.
 - .2 Clean and prepare surfaces, as appropriate for paint specified, in accordance with Commercial Blast Cleaning is only required where zinc rich paint is to be applied. All other steel to be or clean steel in compliance with SSPC SP6 where zinc rich paint is shop applied.
 - .3 Where paint is applied adjacent to welded joints, remove it to bare metal for a distance of at least 50 mm beyond sides of joints.
 - .4 Do not paint surfaces and edges to be field welded, contact surfaces of friction type connections assembled by high strength bolts, surfaces encased in or in contact with concrete.
 - .5 Do not paint surfaces to receive cementitious fireproofing.
 - .6 Prime steel members to receive Intumescent Fireproofing in accordance with fireproofing manufacturer's recommendations. Refer to Section 07 81 23.

3.2 Examination

- .1 Verify, before delivery of structural steel, that work of other Sections on which work of this Section is dependent is correctly installed and located.

3.3 Preparation

- .1 Supply anchor bolts, base and bearing plates and other members to be built in under work of other Sections as the work progresses. Cooperate with installers of this work and provide instructions for setting items to be built in.

3.4 Erection

- .1 Comply with CSA S16 and work site safety plans in erection of work of this Section.
- .2 Make adequate provision for horizontal and vertical erection loads and for sufficient temporary bracing to keep structural frame plumb and in true alignment until the completion of erection, and the installation of masonry, concrete work, and floor and roof decks which provide the necessary permanent bracing.
- .3 Provide temporary steel members as may be required for erection purposes and remove them when no longer required.
- .4 Installation of Bearing and Column Base Plates: Install bearing plates and standard wall anchors for beams bearing on masonry or concrete.

- .1 Set loose beam bearing plates and column base plates, at proper elevation, true and level, with steel shims, ready for grouting as specified under work of other Sections.
- .2 Set loose bearing plates and/or levelling plates to be cast into concrete.

3.5 Coating Touch-Up

- .1 Clean welds with wire brushes and wash down with clean water to ensure no residue from electrodes is present.
- .2 After erection, give one coat of prime coat or zinc rich paint as applicable and specified for shop coat to field bolts, field connections, burnt areas, and abrasions or damage to shop coats.
- .3 Touch up all areas with a specified paint film thickness.
- .4 Give areas of bare metal on galvanized members two coats of zinc-rich paint. Repair coating on architecturally exposed galvanized metals in accordance with reference standards and as directed by the Consultant. Replace any materials where damage cannot be repaired to the satisfaction of the Consultant.

3.6 Field Quality Control

- .1 Inspection and Testing Company, when appointed as specified in Source Quality Control elsewhere in this Section, shall perform:
 - .1 Inspection of erection and fit-up, including placing, plumbing, levelling and temporary bracing and conformance with specified tolerances.
 - .2 Inspection of bolted connections, including verification that ASTM A307, ASTM F3125 snug tight only bolts, and ASTM F3125 pre-tensioned bolts have been installed and used appropriately, and that threads are excluded from shear plane where required.
 - .3 Inspection of welded joints, including slag removal.
 - .4 General inspection of field cutting and alterations; report immediately to Consultant, any alterations or cutting not shown on reviewed shop drawings.
 - .5 General inspection of shop coating touch-up.
 - .6 Inspection of zinc primer and zinc-rich paint, including surface preparation and coating thickness.

3.7 Defective Work

- .1 Variations in excess of specified tolerances, and failure of materials or workmanship to meet requirements of this specification, and which cannot be repaired by approved methods, will be considered defective Work performed by this Section.
- .2 Replace defective Work, as directed by Consultant.
- .3 Pay for additional inspection and testing, redesign, corrective measures, and related expenses if Work has proven to be deficient.

3.8 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 03 30 00 Cast-in-Place Concrete
- .2 Section 04 05 19 Masonry Anchorage and Reinforcing
- .3 Section 04 22 00 Concrete Unit Masonry
- .4 Section 05 12 23 Structural Steel

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM A53/A53M-22 Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
 - .2 ASTM A153/A153M-23 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - .3 ASTM A240/A240M-23a Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - .4 ASTM A307-21 Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - .5 ASTM A385/A385M-22 Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
 - .6 ASTM A1008/A1008M-23e1 Standard Specification for Steel, Sheet, Cold Rolled, Carbon, Structural, High Strength Low Alloy, High Strength Low Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
 - .7 ASTM A1011/A1011M-23 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 - .8 ASTM C1107/C1107M-20 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
 - .9 ASTM D1187/D1187M-97(2018) Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
 - .10 ASTM F3125/F3125M-23 Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
- .2 CSA Group (CSA)
 - .1 CSA G40.21-13 General Requirements for Rolled or Welded Structural Quality Steel.
 - .2 CSA-S16.1-M Limit States Design of Steel Structures.
 - .3 CSA W47.1-09 (R2014) Certification of Companies for Fusion Welding of Steel Structures.
 - .4 CSA W59-18 Welded Steel Construction
 - .5 CSA W178.1-18 Certification of Welding Inspection Organizations
 - .6 CSA W178.2-18 Certification of Welding Inspectors
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.40-97 Anticorrosive Structural Steel Alkyd Primer
 - .2 CAN/CGSB 1.181-99 Ready Mixed, Organic Zinc Rich Coating.
- .4 Canadian Sheet Steel Building Institute (CSSBI)
- .5 Steel Structures Painting Council, Systems and Specifications Manual.
 - .1 CISC/CPMA 1-73a-1975 A Quick drying One-coat Paint for Use on Structural Steel.
 - .2 CISC/CPMA 2-75-1975 A Quick Drying Primer for Use on Structural Steel.

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit Shop and Erection Drawings for review.
 - .2 Verify site dimensions before proceeding with shop fabrication and to suit field conditions and field openings.
 - .3 Show and describe in detail all the work of this Section including large scale detail of members and materials, of connection and jointing details, and of anchorage devices, dimensions, thicknesses, description of materials, metal finishing, as well as all other pertinent data and information, including type, size and description of all fasteners and anchors.
 - .4 Indicate connections to building structure.
 - .5 Shop drawings for all metal fabrications shall be stamped and signed by a Professional Engineer registered in the Province of Ontario. Each submission of the shop drawings shall bear the seal of the Engineer.
- .3 Submit duplicate minimum 300 x 300 mm samples of stainless steel materials in specified finish.

1.5 Qualifications

- .1 Work of this Section shall be executed by a firm thoroughly conversant with laws and regulations which govern and capable of workmanship of best grade of modern shop and field practice known to recognized manufacturers specializing in this work and having a minimum ten (10) years proven experience in the fabrication of high quality metal fabrications. Use workmen skilled in work of this Section.
- .2 Welding shall be performed by trades persons certified by The Canadian Welding Bureau under CSA Standard W47.1.

1.6 Design Requirements

- .1 Design metal handrai construction and connections to OBC vertical and horizontal live load requirements.

1.7 Examination

- .1 All dimensions shall be taken from the drawings and checked against the building. Be responsible for the correctness of such measurements and report to the Consultant in writing all discrepancies between measurements at building and those shown on drawings prior to commencing work. Verify location of anchor bolts and embedded steel and ensure that work prepared by other trades is at a proper elevation, on line, level and true.

1.8 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Label, tag or otherwise mark work supplied for installation by other Sections to indicate its function, location and shop drawing description.
- .3 Protect work from damage and deliver to a location at the site in order to meet the scheduling requirements.

- .4 Protect architecturally exposed materials during fabrication, delivery, handling, storage and erection to prevent marring of surfaces exposed to view, by marking, bending, denting or coarse grinding.

1.9 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 Structural Steel Sections and Steel Plate: CSA G40.20-13/G40.21-13, Grade 350W.
- .2 Architectural and Miscellaneous Mild Steel: CSA G40.20-13/G40.21-13, Grade 300W.
- .3 Steel Pipe: ASTM A53 Schedule 40, Grade B.
- .4 Welding Materials: CSA W59.
- .5 Welding Electrodes: CSA W48 Series.
- .6 Sulphur: Commercial Grade for setting of steel posts.
- .7 Grout: non-shrink, non-metallic, non-stain, flowable, to ASTM C1107, 15 MPa at 24 hours.
- .8 Isolation Coating: Alkali resistant bituminous paint to ASTM D1187.
- .9 Adhesive Anchors: HILTI or Rawl Epoxy Adhesive Anchors sized to suit loading conditions, suitable for substrate. Adhesive to be low VOC type (maximum 250 g/l) to SCAQMD Rule 1168-03, Adhesives and Sealants Applications.

2.2 Finishes

- .1 Primers: All primers for metal fabrications are to be factory applied under the requirements of this Section. Refer to Finish Schedules in Section 09 91 23 for types of primers required for each application. Colour to be grey.
- .2 Zinc Rich Primer: zinc rich, organic, ready mix to CAN/CGSB 1.181. Low VOC type.

PART 3 EXECUTION

3.1 Fabrication

- .1 Fabricate to reviewed shop drawings and in general to details, sizes and materials indicated on drawings and specified herein.
- .2 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.
- .3 Fabricate work complete with all components required for anchoring; bolting or welding to structural frame; standing free or resting in frames or sockets; in a safe and sure manner.
- .4 Where possible fit and shop assemble various sections of the work and deliver to site in largest

practicable sections. Where shop fabricating is not possible, make trial assembly in shop.

- .5 Ensure exposed welds are continuous for length of each joint.
- .6 Grind and fill all welds after inspection and acceptance and leave ready for prime painting.
- .7 Fill all open joints, depressions, seams with metallic paste filler or by continuous brazing or welding and grind smooth to true sharp arises and profiles.
- .8 Fit joints and intersecting members accurately. Make work in true planes with adequate fastenings.
- .9 Supply all fastenings, anchors, accessories required for fabrication and erection of work of this Section. Make thread dimensions such that nuts and bolts will fit without re-threading or chasing threads.
- .10 Welding shall be done by the shielded metal-arc method in accordance with the requirements CSA W59. The welding operators shall be currently certified under CSA W47.1 for the work they are performing.
- .11 Make exposed metal fastenings and accessories of same material, texture, colour and finish as base metal on which they occur unless otherwise shown or specified. Keep exposed fastenings to an absolute minimum evenly spaced and neatly laid out. Make fastenings of permanent type unless otherwise indicated.
- .12 Surfaces to be welded shall be free from loose scale, rust, paint, or other foreign matter. Where weld material is deposited in two or more layers, each layer shall be cleaned before the next layer is deposited. Care shall be taken to minimize stresses due to heat expansion, contraction and distortion by using proper sequence in welding and by approved methods.
- .13 Appearance, quality of welds made, methods of correcting defective work shall be in accordance with CSA W59.

3.2 Shop Painting

- .1 Cleaning Steel:
 - .1 Clean steel, whether it is to be painted or not, to the degree required by CISC/CPMA 1-73a, except as specified below.
 - .2 Steel to receive a shop or field paint finish shall be cleaned in accordance with Sections 09 91 23 or SSPC SP6, whichever produces a surface which has less rust and mill scale.
 - .3 Clean steel which is specified to be painted to CISC/CPMA 2-75 in accordance with that Standard.
 - .4 Clean steel which is specified to receive an organic zinc-filled epoxy primer, or zinc-rich paint, or inorganic zinc primer, in accordance with SSPC-SP 6, Commercial Blast Cleaning.
 - .5 Clean welds by wire brushing and wash down with clean water, to remove the chemical residues left by the electrodes, prior to painting.
- .2 The following surfaces shall not be painted:
 - .1 Surfaces and edges to be field welded. If painted, remove paint for field welding for a distance of at least 50 mm on all sides of the joint, to ensure proper fusion of the metal.
 - .2 The contact surfaces of friction type connections assembled by high strength bolts.
 - .3 Portions of steel members which are to be encased in or in contact with concrete or masonry.
- .3 Preparation and priming of all metal work which will be exposed to view and which is scheduled to be finish painted, shall be in accordance with the requirements of Section 09 91 23.

- .4 All other concealed or unpainted ferrous metal work shall be given one prime paint coat type CGSB 1.40 and in accordance with CISC/CPMA 2-75. Work paint into all corners and all joints. Metal parts in contact shall be primed before shop assembly. Priming damaged during erection or through lack of protection shall be cleaned and touched up.
- .5 Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 ° C.
- .6 Metals in contact with other dissimilar metals, concrete or masonry materials shall be insulated or separated from one another to prevent corrosion, staining or electrolysis by use of bituminous paint.

3.3 Miscellaneous Framing and Supports

- .1 General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- .2 Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 - .1 Furnish inserts for units installed after concrete is placed.
- .3 Prime paint miscellaneous framing and supports..

3.4 Angle Lintels

- .1 Provide all loose steel angle lintels required to support openings and recesses in masonry walls, whether indicated on the drawings or not. Refer to Architectural, Structural and Mechanical drawings for locations of openings. Lintels shall be as scheduled on the Structural drawings.
- .2 Steel angles: CSA G40.21, Grade 300W, sizes indicated for openings. Provide 150 mm minimum bearing at ends unless otherwise indicated.
- .3 Weld or bolt back-to-back angles to profiles as indicated.
- .4 Supply for installation by Sections 04 22 00 and 04 27 00.
- .5 Lintels shall be prime painted unless otherwise indicated.

3.5 Steel Weld Plates and Angles

- .1 Provide steel weld plates and angles not specified in other Sections, for items supported from concrete or masonry construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete or masonry.

3.6 Installation

- .1 Supervise the setting of bases, anchor bolts, and other steel to concrete connections. Cutting of base plates to accommodate anchor bolts is cause for rejection of base plates.
- .2 Provide all bracing and shoring required to support the work of this Section during installation.
- .3 Work shall be fabricated and erected square, plumb and true, straight, level and accurately fitted to

size detailed on reviewed Shop Drawings. All joints shall be welded unless otherwise indicated. Exposed welds shall be ground smooth and/or flush. Exposed work shall be finished smooth and even, close joints and neat connections. Exposed welds continuous for full length of joints.

- .4 Where anchors or fastenings, sleeves, have to be built in by other trades, supply all necessary templates, instructions and supervision to ensure satisfactory installation.
- .5 Do all drilling, cutting and fitting necessary to attach this work to adjoining work and make it complete.
- .6 Provide all components required for anchoring. Make anchoring in concealed manner where possible. Exposed anchors shall be approved by the Consultant, shall be neat, and of the same material, colour, texture and finish of base metal on which they occur. Exposed fastenings shall be evenly spaced.
- .7 Grind all field welds smooth.
- .8 Touch up shop coat of prime paint where damaged by field erection.

3.7 Fasteners and Anchors

- .1 Use methods for fastening or anchoring metal fabrications to building construction as shown or specified.
- .2 Securely anchor components in place. Unless otherwise indicated, anchor components as follows:
 - .1 To concrete and solid masonry with expansion or epoxy adhesive type anchors.
 - .2 To hollow construction with toggle bolts.
 - .3 To thin metal with screws or bolts.
 - .4 To thick metal with bolts or by welding.
 - .5 Fill space between railing members and sleeves with non-shrink grout.
- .3 Where fasteners and anchors are not shown, design the type, size, location and spacing to resist the loads imposed without deformation of the members or causing failure of the anchor or fastener, and suit the sequence of installation.
- .4 Use material and finish of the fasteners compatible with the kinds of materials which are fastened together and their location in the finished work.
- .5 Fasteners for securing metal fabrications to new construction only, may be by use of threaded or wedge type inserts or by anchors for welding to the metal fabrication for installation before the concrete is placed or as masonry is laid.
- .6 Fasteners for securing metal fabrication to existing construction or new construction may be expansion bolts, toggle bolts, power actuated drive pins, welding, self-drilling and tapping screws or bolts.

3.8 Schedule

- .1 General:
 - .1 Supply and install all metal fabrications indicated on Drawings, and not included in the work of other Sections.
 - .2 Coordinate and sequence the work to ensure timely delivery to the site, of all items to be built in.
 - .3 Where items are required to be built into masonry, concrete or other work supply such items to

- respective Sections with all anchors and accessories for building in.
- .4 All items shall be of sizes and as detailed on drawings.
 - .5 Coordinate with Section 09 91 13 and 09 91 23 for preparation of exposed metal items required to have finish coatings applied in the field.
 - .6 Review all coordination drawings prior to installation of materials, to ensure that no interferences with the work of other Sections will occur.

3.9 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Clean exposed prefinished and plated items and items fabricated from stainless steel as recommended by the metal manufacturer and protect from damage until Substantial Performance of the project.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 08 11 00 Metal Doors and Frames
- .2 Section 09 21 16 Gypsum Board
- .3 Section 09 22 16 Non-Structural Metal Framing

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM A123/A123M-17 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - .2 ASTM A653/A653M-23 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
 - .3 ASTM F1667-21a Standard Specification for Driven Fasteners: Nails, Spikes, and Staples
- .2 CSA Group (CSA)
 - .1 CSA A247- M86 (R1996) Insulating Fiberboard.
 - .2 CSA G164-18 Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .3 CSA O80 SERIES-15 Wood Preservation
 - .4 CSA O121-17 Douglas Fir Plywood.
 - .5 CSA O141:23 Canadian Standard Lumber.
 - .6 CSA O151-17 Canadian Softwood Plywood
 - .7 CSA Z809-08 Sustainable Forest Management
- .3 Underwriters Laboratories Canada (ULC)
 - .1 ULC 102-2018 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .4 National Lumber Grading Authority (NGLA)
 - .1 Standard Grading Rules for Canadian Lumber, Latest Edition.
- .5 Forest Stewardship Council (FSC)
 - .1 FSC-STD-01-001-2004 FSC Principle and Criteria for Forest Stewardship.
 - .2 FSC-STD-20-002-2004 Structure and Content of Forest Stewardship Standards V2-1
 - .3 FSC Accredited Certified Bodies.

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Certified Wood: Submit listing of wood products and materials used, produced from wood obtained from forests certified by FSC Accredited Certification Body in accordance with FSC-STD-01-001.

1.5 Quality Assurance

- .1 Sawn lumber shall be identified by the grade stamp of an association or independent grading agency certified by the Canadian Lumber Standards Accreditation Board.

1.6 Shipping, Handling and Storage

- .1 Protect materials, under cover, both in transit and on the site.

- .2 Store materials to prevent deterioration or the loss or impairment of their structural and other essential properties. Do not store materials in areas subject to high humidity and areas where masonry and concrete work are not completely dried out.
- .3 Store sheathing materials level and flat, in a dry location. Protect panel edges from moisture at all times.

1.7 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 Timber Material shall be 'Grade Stamped'.
- .2 CSA Z809 or FSC Certified.
- .3 Construction Lumber: To CSA O141 Softwood Lumber graded to NLGA Standard Grading Rules for Canadian Lumber, published by the National Lumber Grades Authority. All lumber shall bear grade stamps. Moisture content of softwood lumber not to exceed 19% at time of installation.
 - .1 Framing lumber, plates, furring, blocking, No. 1 SPF.
 - .2 Nailing strips, furring and strapping: No. 4 S-P-F.
 - .3 Fitment framing: No. 1 S-P-F.
- .4 Canadian Softwood Plywood: to CSA O151-M, standard construction, good one or both sides as required, thickness as shown or specified.
- .5 Douglas Fir Plywood: To CSA O121-M, standard construction, good one side, thickness as shown on the drawings.
- .6 Nails, Spikes and Staples: To ASTM F1667.
- .7 Sheathing Screws: ASTM C1002, corrosion resistant treated. Length of screws to penetrate framing minimum 13 mm.
- .8 Bolts: 12.5 mm diameter, galvanized, complete with nuts and washers.
- .9 Proprietary Fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, recommended for purpose by manufacturer.
- .10 Wood Preservative to CSA O80 SERIES.
- .11 Adhesive: Contractors gun grade cartridge loaded wood adhesive, general purpose, to ASTM D2559.
- .12 Galvanizing: to CSA-G164. Use galvanized fasteners, and hardware for materials in contact with concrete or masonry.

3.1 Installation

- .1 Workmanship

- .1 Execute work using skilled mechanics according to best practice, as specified here.
- .2 Lay out work carefully and to accommodate work of other trades. Accurately cut and fit; erect in proper position true to dimensions; align, level, square, plumb, adequately brace, and secure permanently in place. Join work only over solid backing.
- .2 Rough Hardware: Include rough hardware such as nails, bolts, nuts, washers, screws, clips, and hangers.
- .3 Provide treated wood nailers, blocking, cants, grounds, furring and similar members where shown and where required for screeding or attachment of other work and surface applied items. Attach to substrate as required to support applied loading.
- .4 Blocking: Provide solid wood backing to support millwork, cabinetwork, equipment, fixtures, railings and accessories and the like, as required. Coordinate with work of other Sections and install all required backing. Any such equipment mounted on gypsum wallboard assemblies or similar assemblies shall be adequately supported.
 - .1 Provide solid wood blocking in all partitions where wall stops are specified in the hardware schedule.
- .5 Drywall Partition Backing:
 - .1 Install 16 mm D. Fir plywood on metal studs in all reinforced partitions where indicated.
 - .2 Fasten plywood to metal studs with sheet metal sheathing screws at 12" c/c maximum.
- 3.1 Cleaning
 - .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 03 30 00 Cast-in-Place Concrete
- .2 Section 09 65 66 Indoor Athletic Surfacing
- .3 Section 09 65 70 Resilient Sheet Flooring

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM C78/C78M-22 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
 - .2 ASTM C109/C109M-21 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
 - .3 ASTM C1583/C1583M-20 Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)
 - .4 ASTM D1308-20 Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems
 - .5 ASTM E96/E96M-22ae1 Standard Test Methods for Water Vapor Transmission of Materials
 - .6 ASTM F710-22 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
 - .7 ASTM F2170-19a Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Test Results: submit moisture vapour emission test data.
- .3 Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

1.5 Quality Assurance

- .1 Installation of the products must be completed by a manufacturer's certified applicator.
- .2 Manufacturer Experience: Provide products of this section by companies which have successfully specialized in production of this type of work for not less than 5 years.

1.6 Project Conditions

- .1 Do not install material below 10 °C surface and air temperatures. These temperatures must also be maintained during and for 48 hours after the installation of products included in this section.

1.7 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.
- .3 Deliver products in original packaging, labeled with product identification, manufacturer, batch number and shelf life.
- .4 Store products in a dry area with temperature maintained between 10 ° and 29 °C and protect from direct sunlight.
- .5 Handle products in accordance with manufacturers printed recommendations.

1.8 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

1.9 Warranty

- .1 Warrant the work of this Section against defects of workmanship and material, for a period of ten years from the date of Substantial Performance and agree to make good promptly any defects which occur or become apparent within the warranty period.

PART 2 PRODUCTS

2.1 Topical Moisture Mitigation System

- .1 Two-Coat Moisture Control System for Concrete:
 - .1 Acceptable Products: ARDEX MC PLUS; Manufactured by ARDEX Engineered Cements: 400 Ardex Park Drive, Aliquippa, Pa 15001 USA 724-203-5000
 - .2 Performance and Physical Properties: Meet or exceed the following values for material cured at 21° C+/-3°C and 50% +/-5% relative humidity:
 - .1 Application: Roller
 - .2 Permeability: 0.12 perms (<.10 perms with sand in 2nd Coat), ASTM E96
 - .3 14 pH solution: No effect, ASTM D1308
 - .4 VOC: 0g/l, calculated SCAQMD 1168

2.2 Hydraulic Cement Underlayment

- .1 Hydraulic Cement-based Self-Leveling Underlayment
 - .1 Acceptable Products:
 - .1 ARDEX K 15; Manufactured by ARDEX Engineered Cements: 400 Ardex Park Drive, Aliquippa, Pa 15001 USA, (724) 203-5000, www.ardex.com
 - .1 Primer: No additional primer required
 - .2 ARDEX K 55, Manufactured by ARDEX Engineered Cements: 400 Ardex Park Drive, Aliquippa, Pa 15001 USA, (724) 203-5000, www.ardex.com
 - .1 Primer: No additional primer required
 - .2 Performance and Physical Properties: Meet or exceed the following values for material cured at 21° C+/-3°C and 50% +/-5% relative humidity:
 - .1 Application: Barrel Mix or Pump

- .2 Flow Time: 10 minutes
- .3 Initial Set: Approx. 30 minutes
- .4 Final Set: Approx. 90 minutes
- .5 Compressive Strength: Minimum 4100 psi at 28 days, ASTM C109M.
- .6 Flexural Strength: 1000 psi at 28 days, ASTM C78.
- .7 VOC: 0 g/l, calculated SCAQMD 1168

2.3 Water

- .1 Water shall be clean, potable, and sufficiently cool (not warmer than 20 °C).

PART 3 EXECUTION

3.1 Preparation

- .1 Concrete Subfloors: Prepare substrate in accordance with manufacturer's instructions and ASTM F710. All concrete subfloors must be sound, solid, clean, and free of all oil, grease, dirt, curing compounds and any substance that might act as a bond breaker before application.
 - .1 Mechanical preparation of the surface is required to obtain a minimum ICRI concrete surface profile of 3 (CSP 3). This substrate preparation must be by mechanical means, such as shot blasting.
 - .2 The concrete must have a minimum tensile strength of at least 200 psi when tested in accordance with ASTM C1583. The concrete surface must be free of standing water.
 - .3 Prior to beginning the installation, measure the relative humidity within the concrete (ASTM F2170). Alternatively, measure the surface relative humidity in accordance with ASTM F2420. For these relative humidity methods, the RH shall not exceed 100%.
 - .4 If the concrete substrate is too uneven to provide a uniform film thickness of the moisture control system (typically CSP 6 or higher), the substrate shall be pre-smoothed using self-leveling exterior concrete topping or moisture resistant patch.
- .2 Joint Preparation
 - .1 Moving Joints: honour all expansion and isolation joints up through the moisture mitigation system and underlayment.
 - .2 Saw Cuts and Control Joints – fill all non-moving joints with joint filler as recommended by the manufacturer.

3.2 Application

- .1 Examine substrates and conditions under which materials will be installed. Do not proceed with installation until unsatisfactory conditions are corrected.
- .2 Coordinate installation with adjacent work to ensure proper sequence of construction. Protect adjacent areas from contact due to mixing and handling of materials.
- .3 Mix and apply primer and sealer in accordance with manufacturer's written instructions.

3.3 Field Quality Control

- .1 Where specified, field sampling is to be done by taking an entire unopened bag/unit of the product being installed to an independent testing facility to perform testing. There is no in-situ test method applicable for this system.

3.4 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

3.5 Protection

- .1 Prior to the installation of the finish flooring, the surface of the underlayment shall be protected from abuse by other trades by the use of plywood, Masonite or other suitable protection course.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 07 84 00 Firestopping

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM E84-26 Standard Test Method for Surface Burning Characteristics of Building Materials
 - .2 ASTM E605/E605M-19 Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
- .2 Underwriters Laboratories Inc. (ULC)
 - .1 CAN/ULC 102:2019 (R2024) Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit product data.
- .3 Submit manufacturer's instructions for proper application of fireproofing sealer.

1.5 Quality Assurance

- .1 Fireproofing sealer work shall be performed by a firm acceptable to the material manufacturer.

1.6 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

1.7 Protection

- .1 Install temporary partitions in order to prevent any overspray outside of the work area from the sprayed-on fireproofing sealer.
- .2 Protect all adjacent surfaces and equipment against any damage that may be caused by dispersion and overspray of fireproofing sealer material beyond prescribed limits.

1.8 Project Conditions

- .1 A minimum air and substrate temperature of 4 °C shall be present before application of fireproofing sealer. Maintain a minimum air and substrate temperature of 4 °C during and for 24 hours after application. Provide enclosures with heat to maintain temperature.

- .2 Provide ventilation to achieve a minimum total fresh air exchange rate of 4 times per hour until the material is substantially dry.

1.9 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Fireproofing Sealer

- .1 Fireproofing sealer shall be Carboline TC-55 water-based vinyl acrylic copolymer emulsion of fine particle size. Films retain high degree of flexibility and elongation.
 - .1 Performance Data:
 - .1 ASTM E84 Surface Burning Class A
 - .2 CAN/ULC-S102 Surface Burning FS-5, SD-0
 - .3 ASTM E605 Density 1089.36kg/m³
 - .4 Film Clarity Very Good
 - .5 Film Gloss Very Good
 - .6 Film Hardness Soft and flexible
 - .7 Free Monomer 0.5% maximum
 - .8 Freeze/Thaw Stability Very Good
 - .9 Particle Size 0.2-0.5 microns
 - .10 pH @ 25°C 4.0-5.0
 - .2 Colour: Clear.
- .2 Water: clean potable water.

PART 3 EXECUTION

3.1 Inspection

- .1 All surfaces to receive fireproofing sealer shall be free of oil, grease, condensation or other foreign substances which may impair proper adhesion of the fireproofing sealer to the substrate.

3.2 Application

- .1 Mix and apply fireproofing sealer over existing cementitious fireproofing in accordance with manufacture's written instructions.
- .2 Use standard spray equipment or brush for application.
- .3 Wet Film Thickness minimum 4 mils (100 microns)

3.3 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 04 22 00 Concrete Unit Masonry
- .2 Section 07 92 00 Joint Sealants
- .3 Section 09 21 16 Gypsum Board

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM E84-23d Standard Test Method for Surface Burning Characteristics of Building Materials
 - .2 ASTM E119-20 Standard Test Methods for Fire Tests of Building Construction and Materials
 - .3 ASTM E136-19a Standard Test Method for Behavior of Material in a Vertical Tube Furnace at 750° C
 - .4 ASTM E814-13a (2017) Standard Test Method for Fire Tests of Penetration Firestop Systems
 - .5 ASTM E1966-15(2019) Standard Test Method for Fire-Resistive Joint Systems
 - .6 ASTM E2307-20 Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus
- .2 Underwriter's Laboratories of Canada (ULC)
 - .1 ULC 101-2014 Standard Methods of Fire Endurance Tests of Building Construction and Materials
 - .2 ULC 102.2-2018 Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies
 - .3 ULC 115-2018 Standard Method of Fire Tests of Firestop Systems
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 252 Standard Methods of Fire Test and Door Assemblies
- .4 South Coast Air Quality Management District (SCAQMD) California State
 - .1 SCAQMD Rule 1168-03: Adhesives and Sealants.
- .5 Ontario Building Code

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings: Submit shop drawings to show location, proposed material, reinforcement, anchorage, fastenings and method of installation. Construction details should accurately reflect actual job conditions.
- .4 Samples: Submit duplicate 300 x 300 mm samples showing actual fire stop material proposed for project.
- .5 Quality Assurance Submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: in accordance with ULC 101 for fire endurance and ULC 102 for surface burning

characteristics.

- .2 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

1.5 Definitions

- .1 Fire Stop Material: device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.
- .2 Single Component Fire Stop System: fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.
- .3 Multiple Component Fire Stop System: exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.

1.6 Quality Assurance

- .1 One installer shall install all firestopping on the project. Each trade shall not firestop their own service penetrations. Installer shall be certified by fire stopping manufacturer.
- .2 Qualifications:
 - .1 Qualified Installer: specializing in fire stopping installations with 5 years documented experience approved and trained by manufacturer.
- .3 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section, with contractor's representative and Consultant to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .4 Site Meetings:
 - .1 As part of Manufacturer's Services described in 3.5- Field Quality Control, schedule site visits, to review Work, at stages listed.
 - .2 After delivery and storage of products, and when preparatory Work is complete, but before installation begins.
 - .3 Twice during progress of Work at 25% and 60% complete.
 - .4 Upon completion of Work, after cleaning is carried out.
 - .5 Single Source Responsibility: Obtain through-penetration fire-stop systems for each kind of penetration and construction condition indicated from a single manufacturer.
- .5 Field-Constructed Mockup: Prior to installing fire-stopping, erect mockups for each different through-penetration fire-stop system indicated to verify selections made and to demonstrate qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final installations.
 - .1 Locate mockups on site in locations indicated or, if not indicated, as directed by Consultant.

- .2 Notify Consultant one week in advance of the dates and times when mockups will be erected.
- .3 Obtain Consultant's acceptance of mockups before start of final unit of Work.
- .4 Retain and maintain mockups during construction in an undisturbed condition as a standard for judging completed unit of Work.
- .5 Accepted mockups in an undisturbed condition at time of Substantial Performance may become part of completed unit of Work.

1.7 Sustainable Requirements

- .1 Materials shall be Low VOC type conforming to SCAQMD Rule 1168-03. Maximum VOC level of firestopping materials shall be 250 g/l.

1.8 Project Conditions

- .1 Environmental Conditions: Do not install fire-stopping when ambient or substrate temperatures are outside limits permitted by fire-stopping manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- .2 Ventilation: Ventilate fire-stopping per fire-stopping manufacturers' instructions by natural means or, where this is inadequate, forced air circulation.

1.9 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.
- .3 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, ULC markings.
- .4 Storage and Protection:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

1.10 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 All fire stopping shall consist of ULC listed firestop system.
- .2 Applications: Provide fire-stopping systems composed of materials specified in this Section that comply with system performance and other requirements.
- .3 General: Provide fire-stopping systems that are produced and installed to resist the spread of fire, according to requirements indicated, and the passage of smoke and other gases.
- .4 All firestopping material shall be:
 - .1 From one manufacturer;
 - .2 Intumescent where an appropriate system exists.

- .5 Fire stopping and smoke seal systems: ULC listed in accordance with ULC 115.
 - .1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases in compliance with requirements of ULC 115 and not to exceed opening sizes for which they are intended.
- .6 Service penetration assemblies: ULC listed systems tested to ULC 115.
- .7 Service penetration fire stop components: ULC listed and certified by test laboratory to ULC 115.
- .8 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.
- .9 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- .10 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- .11 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .12 Water: potable, clean and free from injurious amounts of deleterious substances.
- .13 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.
- .14 F-Rated Through-Penetration Fire-stop Systems: Provide through-penetration fire-stop systems with F ratings indicated, but not less than that equaling or exceeding the fire-resistance rating of the constructions penetrated.
- .15 T-Rated Through-Penetration Fire-stop Systems: Provide through-penetration fire-stop systems with T ratings, in addition to F ratings, where indicated and where systems protect penetrating items exposed to contact with adjacent materials in occupy-able floor areas. T-rated assemblies are required where the following conditions exist:
 - .1 Where fire-stop systems protect penetrations located outside of wall cavities.
 - .2 Where fire-stop systems protect penetrations located outside fire-resistive shaft enclosures.
 - .3 Where fire-stop systems protect penetrations located in construction containing doors required to have a temperature-rise rating.
 - .4 Where fire-stop systems protect penetrating items larger than a 100 mm diameter nominal pipe or 10,000 mm² in overall cross-sectional area.
- .16 Fire-Resistive Joint Sealants: Provide joint sealants with fire-resistance ratings indicated, but not less than that equaling or exceeding the fire-resistance rating of the construction in which the joint occurs. Sealants for vertical joints: non-sagging.
- .17 For fire-stopping exposed to view, traffic, moisture, and physical damage, provide products that do not deteriorate when exposed to these conditions.
 - .1 For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration fire-stop systems.
 - .2 For floor penetrations with annular spaces exceeding 100 mm or more in width and exposed to possible loading and traffic, provide fire-stop systems capable of supporting the floor loads involved either by installing floor plates or by other means.
 - .3 For penetrations involving insulated piping, provide through-penetration fire-stop systems not requiring removal of insulation.

- .18 For firestopping exposed to view, provide products with flame-spread values of less than 25 and smoke-developed values of less than 450.
- .19 Compatibility: Provide fire-stopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by fire-stopping manufacturer based on testing and field experience.
- .20 Accessories: Provide components for each fire-stopping system that are needed to install fill materials and to comply with "System Performance Requirements". Use only components specified by the fire-stopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire resistance-rated systems. Accessories include but are not limited to the following items:
 - .1 Permanent forming/damming/backing materials including the following:
 - .1 Semi-refractory fibre (mineral wool) insulation.
 - .2 Ceramic fibre.
 - .3 Sealants used in combination with other forming/damming materials to prevent leakage of fill materials in liquid state.
 - .4 Fire-rated formboard.
 - .5 Joint fillers for joint sealants.
 - .2 Temporary forming materials.
 - .3 Substrate primers.
 - .4 Collars.
 - .5 Steel sleeves.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications.

3.2 Preparation

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.
- .2 Ensure that substrates and surfaces are clean, dry and frost free.
- .3 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .4 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour retarder.
- .5 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.3 Installation

- .1 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing and as necessary to maintain fire resistance ratings of floor and wall assemblies.

- .2 Provide fire stopping for all disciplines.
- .3 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .4 Fill spaces between openings, ducts, pipes and unused sleeves passing through fire separations with firestop material and install firestopping systems in accordance with the appropriate ULC system number for the products and type of penetration.
- .5 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .6 Tool or trowel exposed surfaces to neat finish.
- .7 Remove excess compound promptly as work progresses and upon completion.

3.4 Sequences of Operation

- .1 Proceed only when submittals have been reviewed by Consultant.
- .2 Mechanical pipe insulation: certified fire stop system component.
 - .1 Ensure pipe insulation installation precedes fire stopping.

3.5 Field Quality Control

- .1 Inspections: notify Consultant when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.
- .2 Employ a ULC accredited Designated Responsible Individual (DRI) to inspect and label all fire stop applications on site.
- .3 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in Article 1.4 - Submittals.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in Article 1.6 - Quality Assurance.

3.6 Commissioning

- .1 Employ a ULC accredited Designated Responsible Individual (DRI) to inspect and label all fire stop applications on site. Submit DRI's written reports within 3 days of review, verifying compliance of Work.
- .2 Perform a thorough examination of the fire stopping system to determine if the assembly is installed as per its ULC listing.
- .3 Allow for destructive testing of installed firestopping. Repair all tested assemblies.
- .4 The examination shall take place prior to close-up to confirm assembly components and installation configuration.

- .5 Any and all deviations from the ULC listed system shall be considered grounds for rejection and replacement.

3.7 Schedule

- .1 Fire stop and smoke seal at:
 - .1 Penetrations through fire-resistance rated partitions and walls.
 - .2 Perimeter of fire-resistance rated partitions.
 - .3 Intersection of fire-resistance rated partitions.
 - .4 Control and sway joints in fire-resistance rated partitions and walls.
 - .5 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
 - .6 Around mechanical and electrical assemblies penetrating fire separations.
 - .7 Rigid ducts: greater than 129 cm²: fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.
 - .8 All electrical boxes installed in fire rated gypsum board assemblies.
 - .9 All locations required by the Ontario Building Code.
 - .10 Any other locations indicated.

3.8 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Remove temporary dams after initial set of fire stopping and smoke seal materials.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 06 10 00 Rough Carpentry
- .2 Section 08 11 00 Metal Doors and Frames

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM C719-22 Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
 - .2 ASTM C794-18(2022) Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
 - .3 ASTM C834-17 Standard Specification for Latex Sealants
 - .4 ASTM C919-22 Standard Practice for Use of Sealants in Acoustical Applications
 - .5 ASTM C920-18 Standard Specification for Elastomeric Joint Sealants
 - .6 ASTM C1193-16 Standard Guide for Use of Joint Sealants
 - .7 ASTM C1330-23 Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
 - .8 ASTM D412-16(2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
 - .9 ASTM E84-23c Standard Test Method for Surface Burning Characteristics of Building Materials
 - .10 ASTM E90-09(2016) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- .2 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act, 1999 (CEPA).
- .3 U. S. Environmental Protection Agency (EPA)
 - .1 EPA 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings.
- .4 South Coast Air Quality Management District (SCAQMD) California State
 - .1 SCAQMD Rule 1168-03: Adhesives and Sealants.

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit product data for all sealant materials and accessories including:
 - .1 Preparation instructions and recommendations.
 - .2 Standard drawings illustrating manufacturer's recommended sealant joint profiles and dimensions applicable to Project.
- .3 Joint Sealant Schedule: Indicate joint sealant location, joint sealant type, manufacturer and product name, and colour, for each application. Utilize joint sealant designations included in this Section.
- .4 Samples:
 - .1 Samples for Colour Selection: For each joint sealant type.
 - .2 Samples for Verification: For each joint sealant product, for each colour selected.
- .5 Greenguard Certificates: For each sealant and accessory product specified to meet volatile organic

emissions standards of the Greenguard Children and Schools Certification.

1.5 Quality Assurance

- .1 Installer Qualifications: Company with minimum of three years of experience specializing in work of this section, employing applicators trained for application of joint sealants required for this project, with record of successful completion of projects of similar scope, and approved by manufacturer.
- .2 Single Source Responsibility: Provide joint sealants by a single manufacturer responsible for testing of Project substrates to verify compatibility and adhesion of joint sealants.
- .3 Caulking work shall be carried out in strict accordance with manufacturer's printed directions.
- .4 Preconstruction Manufacturer Laboratory Compatibility, Staining, and Adhesion Testing: Submit samples of each substrate or adjacent material that will be in contact with or affect joint sealants. Current manufacturer test data of products on matching substrates will be acceptable.
- .5 Adhesion: Use ASTM C719 and ASTM C794 to determine requirements for joint preparation, including cleaning and priming.

1.6 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

1.7 Project Conditions

- .1 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.
- .2 Ventilate area of work by use of approved portable supply and exhaust fans.

1.8 Scheduling

- .1 Ensure sealants are cured before covering with other materials.

1.9 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Manufacturer

- .1 Basis-of-Design Products: Provide joint sealant products manufactured by Tremco, Inc., Commercial Sealants and Waterproofing, 220 Wicksteed Avenue, Toronto, www.tremcosealants.com, or comparable products of other manufacturer approved by Consultant.

2.2 Materials, General

- .1 VOC Content for Interior Applications: Provide sealants and sealant primers complying with the following VOC content limits per 40 CFR 59, Subpart D (EPA Method 24):
 - .1 Architectural Sealants: 250 g/L.
 - .2 Sealant Primers for Nonporous Substrates: 250 g/L.

- .3 Sealant Primers for Porous Substrates: 775 g/L.
- .2 Low-Emitting Sealants for Interior Applications: Provide sealants and sealant primers complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .3 Compatibility: Provide joint sealants and accessory materials that are compatible with one another, and with adjacent materials, as demonstrated by sealant manufacturer
- .4 Joint Sealant Standard: Comply with ASTM C920 and other specified requirements for each joint sealant.

2.3 Silicone Joint Sealants

- .1 SJS#1: Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C920, Type S, Grade NS, Class 25, Use NT.
 - .1 Basis of Design Product: Tremco Tremsil 200 Sanitary.
 - .2 Volatile Organic Compound (VOC) Content: 1 g/L maximum.
 - .3 Volatile Organic Emissions (VOE): Not greater than Greenguard Children & Schools Certification emissions levels.
 - .4 Colour: White and Clear.

2.4 Urethane Joint Sealants

- .1 UJS#1: Single-Component, Nonsag, Moisture-Cure, Polyurethane Joint Sealant: ASTM C920, Type S, Grade NS, Class 50, Use NT; Greenguard certified.
 - .1 Basis of Design Product: Tremco Dymonic 100.
 - .2 Volatile Organic Compound (VOC) Content: 40 g/L maximum.
 - .3 Volatile Organic Emissions (VOE): Not greater than Greenguard Children & Schools Certification emissions levels.
 - .4 Tensile Strength ASTM D412: 350 to 450 psi
 - .5 Percent Elongation ASTM D412: 800 to 900%
 - .6 Modulus at 100% ASTM D412: 75 to 85 psi
 - .7 Tear Strength ASTM D412: 65 to 75 psi
 - .8 Smoke Development ASTM E84: 5
 - .9 Colour: As selected by Consultant from manufacturer's standard line.
- .2 UJS#2: Immersible, Single-Component, Pourable, Traffic Grade Polyurethane Joint Sealant: ASTM C920, Type S, Grade P, Class 50, Use T and I.
 - .1 Basis of Design Product: Tremco Vulkem 45 SSL.
 - .2 Volatile Organic Compound (VOC) Content: 110 g/L maximum.
 - .3 Volatile Organic Emissions (VOE): Not greater than Greenguard Children & Schools Certification emissions levels.
 - .4 Colour: As selected by Consultant from manufacturer's standard line.

2.5 Latex Joint Sealants

- .1 LJS#1: Latex Joint Sealant: Siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
 - .1 Basis of Design Product: Tremco Tremflex 834.
 - .2 Volatile Organic Compound (VOC) Content: 35 g/L maximum.
 - .3 Volatile Organic Emissions (VOE): Not greater than Greenguard Children & Schools Certification emissions levels.
 - .4 Colour: White, paintable.

2.6 Acoustical Sealants

- .1 AJS#1: Acoustical/Curtainwall Sealant: Single-component, non-hardening, non-sag, paintable synthetic rubber-tested to reduce airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing of similar assemblies according to ASTM E90.
 - .1 Basis of Design Product: Tremco Acoustical/Curtainwall Sealant.
 - .2 Volatile Organic Compound (VOC) Content: 160 g/L maximum.
 - .3 Colour: White, paintable.

2.7 Joint Sealant Accessories

- .1 Cylindrical Sealant Backing: ASTM C1330, Type B non-absorbent, bi-cellular material with surface skin, or Type O open-cell polyurethane, as recommended by sealant manufacturer for application.
- .2 Bond Breaker Tape: Polymer tape compatible with joint sealant and adjacent materials and recommended by sealant manufacturer.
- .3 Joint Substrate Primers: Substrate primer recommended by sealant manufacturer for application.
- .4 Cleaners: Chemical cleaners acceptable to joint sealant manufacturer.
- .5 Masking tape: Non-staining, non-absorbent tape product compatible with joint sealants and adjacent joint surfaces.

PART 3 EXECUTION

3.1 Examination

- .1 Examine joint profiles and surfaces to determine if work is ready to receive joint sealants. Verify joint dimensions are adequate for development of sealant movement capability. Verify joint surfaces are clean, dry, and adequately cured. Proceed with joint sealant work once conditions meet sealant manufacturer's written recommendations.

3.2 Preparation

- .1 Joint Surface Cleaning: Clean joints prior to installing joint sealants using materials and methods recommended by sealant manufacturer. Comply with ASTM C1193.
 - .1 Remove curing compounds, laitance, form-release agents, dust, and other contaminants.
 - .2 Clean nonporous and porous surfaces utilizing chemical cleaners acceptable to sealant manufacturer.
 - .3 Protect elements surrounding the Work of this section from damage or disfiguration. Apply masking tape to adjacent surfaces when required to prevent damage to finishes from sealant installation.

3.3 Application

- .1 Sealant and Primer Installation Standard: Comply with ASTM C1193 and manufacturer's written instructions.
- .2 Joint Backing: Select joint backing materials recommended by sealant manufacturer as compatible with sealant and adjacent materials. Install backing material at depth required to produce profile of joint sealant allowing optimal sealant movement.
 - .1 Install joint backing to maintain the following joint ratios:

- .1 Joints up to 13 mm wide: 1:1 width to depth ratio.
- .2 Joints greater than 13 mm wide: 2:1 width to depth ratio; maximum 13 mm joint depth.
- .2 Install bond breaker tape over substrates when sealant backings are not used.
- .3 Masking: Mask adjacent surfaces to prevent staining or damage by contact with sealant or primer.
- .4 Joint Priming: Prime joint substrates when recommended by sealant manufacturer or when indicated by preconstruction testing or experience. Apply recommended primer using sealant manufacturer's recommended application techniques.
- .5 Liquid Sealant Application: Install sealants using methods recommended by sealant manufacturer, in depths recommended for application. Apply in continuous operation from bottom to top of joint vertically and horizontally in a single direction. Apply using adequate pressure to fill and seal joint width.
 - .1 Tool sealants immediately with appropriately shaped tool to force sealants against joint backing and joint substrates, eliminating voids and ensuring full contact.
 - .2 Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
 - .3 Tool exposed joint surface concave using tooling agents approved by sealant manufacturer for application.
- .6 Cleaning: Remove excess sealant using materials and methods approved by sealant manufacturer that will not damage joint substrate materials.
 - .1 Remove masking tape immediately after tooling joint without disturbing seal.
 - .2 Remove excess sealant from surfaces while still uncured.
- .7 Installation of Acoustical Sealant: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations on both sides of assemblies with a continuous bead of acoustical sealant. Comply with ASTM C919 and with manufacturer's written recommendations.

3.4 Field Quality Control

- .1 Field-Adhesion Testing: Perform adhesion tests in accordance with manufacturer's instructions and with ASTM C1193, Method A.
 - .1 Perform 5 tests for the first 300 m of joint length for each kind of sealant and joint substrate, and one test for each 300 m of joint length thereafter or 1 test per each floor per building elevation, minimum.
 - .2 For sealant applied between dissimilar materials, test both sides of joint.
- .2 Remove sealants failing adhesion test, clean substrates, reapply sealants, and re-test. Test adjacent sealants to failed sealants.
- .3 Submit report of field adhesion testing to Consultant indicating tests, locations, dates, results, and remedial actions taken.

3.5 Interior Joint Sealant Schedule

- .1 Interior vertical movement joints in interior concrete and unit masonry.
 - .1 UJS#1: Single-component non-sag urethane sealant.
- .2 Interior movement joints in interior unit masonry.
 - .1 UJS#1: Single-component non-sag urethane sealant.

- .3 Interior perimeter joints of interior frames.
 - .1 LJS#1: Siliconized acrylic latex
- .4 Interior sanitary joints between plumbing fixtures and adjacent walls and floors.
 - .1 SJS#1: Mildew-Resistant, Single-Component, nonsag, acid-curing silicone joint sealant.
- .5 Interior traffic joints in floor and between floor and wall construction.
 - .1 UJS# 2: Single-component pourable urethane sealant.
- .6 Interior non-moving joints between interior painted surfaces and adjacent materials.
 - .1 LJS#1: Siliconized acrylic latex
 - .2 Joint-Sealant Colour: Paintable.
- .7 Interior exposed and non-exposed acoustical applications.
 - .1 AJS#1: Acoustical joint sealant.

3.6 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 06 10 00 Rough Carpentry
- .2 Section 07 92 00 Joint Sealants
- .3 Section 08 71 10 Door Hardware
- .4 Section 09 21 16 Gypsum Board
- .5 Section 09 22 16 Non-Structural Metal Framing
- .6 Section 09 91 23 Interior Painting

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM A653/A653M-23 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - .2 ASTM C177-19e1 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
 - .3 ASTM C518-21 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
 - .4 ASTM C591-22 Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
 - .5 ASTM C1289-22a Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
 - .6 ASTM D6386-22 Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
 - .7 ASTM D7396-14(2020) Standard Guide for Preparation of New, Continuous Zinc-Coated (Galvanized) Steel Surfaces for Painting
 - .8 ASTM E90-09(2016) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .9 ASTM E330/E330M-14(2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99 Ready-Mixed Organic Zinc-Rich Coating.
- .3 CSA Group (CSA)
 - .1 CSA-G40.20-13/G40.21-13 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CSA W59-18 Welded Steel Construction (Metal Arc Welding).
- .4 Canadian Steel Door Manufacturers' Association (CSDMA)
 - .1 CSDMA Recommended Dimensional Standards for Commercial Steel Doors and Frames, 2000
 - .2 CSDMA Recommended Specifications for Commercial Steel Doors and Frames, 2006.
 - .3 CSDMA Selection and Usage Guide for Commercial Steel Door and Frame Products, 2009.
- .5 American National Standards Institute (ANSI)
 - .1 ANSI 250.4-2018 Test Procedure and Acceptance Criteria for — Physical Endurance for Steel Doors, Frames and Frame Anchors
 - .2 ANSI 250.10-2011 Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Provide shop drawings
 - .1 Indicate each type of door, frame, steel, construction and core.
 - .2 Indicate material thicknesses, mortises, reinforcements, anchorages, location of exposed fasteners, openings, arrangement of hardware, and finishes.
 - .3 Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and door schedule.

1.5 System Description

- .1 Design exterior frame assembly to accommodate expansion and contraction when subjected to minimum and maximum surface temperature of -35° C to 35° C.

1.6 Defining Opening Sizes

- .1 Width - Widths of openings shall be measured from inside to inside of frame jamb rabbets. (Referred to as "frame rabbet width" or "nominal door width")
- .2 Height - Heights of openings shall be measured from the finished floor (exclusive of floor coverings) to the head rabbet of the frame. (Referred to as "frame rabbet height" or "nominal door height")
- .3 Door Sizes - Doors shall be sized so as to fit the above openings and allow a 3 mm nominal clearance at jambs and head of frame. A clearance of 13 mm maximum shall be allowed between the bottom of the door and the finished floor (exclusive of floor coverings).
- .4 Tolerances - Doors and frame product shall be manufactured and installed in accordance with the CSDMA's, "Recommended Dimensional Standards for Commercial Steel Doors and Frames".

1.7 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.
- .3 Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.

1.8 Testing and Performance

- .1 Product quality shall meet the standards established by the Canadian Steel Door Manufacturer's Association.
- .2 Door construction shall meet acceptance criteria of ANSI A250.10 and shall be certified as meeting Level A (1,000,000 cycles) and Twist Test Acceptance Criteria deflection not to exceed 6.4 mm/13.6 kg force, total deflection at 136.1 kg force not to exceed 64 mm and permanent deflection not to exceed 3.0 mm when tested in strict conformance with ANSI A250.4. Test shall be conducted by an independent nationally recognized accredited laboratory.

1.9 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 Acceptable Materials
 - .1 Steel doors and frame product manufactured in accordance with this Specification by CSDMA members, are eligible for use on this project.
- .2 Steel: Commercial grade steel to ASTM A653, CS, Type B, Coating Designation ZF75 (A25) minimum. Minimum steel thicknesses shall be in accordance with Appendix 1 of the CSDMA, Recommended Specifications for Commercial Steel Door and Frame Products unless noted otherwise.
- .3 Reinforcement channel: to CSA G40.20/G40.21, Type 44W, coating designation to ASTM A653, ZF75.
- .4 Door Core Materials
 - .1 Interior Doors: Structural small cell, 24.5mm maximum kraft paper 'honeycomb'. Weight 36.3 kg per ream minimum, density: 16.5 kg/m³ minimum sanded to required thickness. ULC approved.
- .5 Primers:
 - .1 Touch-up prime CAN/CGSB-1.181, organic zinc rich, rust inhibitive.
 - .1 Maximum VOC limit 50 g/L to GC-03.

2.2 Adhesives

- .1 Adhesive: maximum VOC content 50 g/L to SCAQMD Rule 1168.
- .2 Honeycomb cores and steel components: heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.
- .3 Polyisocyanurate: heat resistant, epoxy resin based, low viscosity, contact cement.
- .4 Lock-seam doors: fire resistant, resin reinforced polychloroprene, high viscosity, low VOC sealant/adhesive or U.L.C. approved equivalent.

2.3 Accessories

- .1 Door silencers: single stud rubber/neoprene type.
- .2 Metallic paste filler: to manufacturer's standard.
- .3 Sealant: As specified in Section 07 92 00.

2.4 Fabrication - Frame Products

- .1 General
 - .1 Fabricate frames in accordance with CSDMA specifications.
 - .2 Fabricate frames to profiles and maximum face sizes as indicated.
 - .3 Exterior frame product shall be 1.60 mm welded type construction, thermally broken.
 - .4 Interior frame product shall be 1.60 mm. Interior frames, transoms, sidelights and window assemblies shall be welded type construction.

- .5 Blank, reinforce, drill and tap frames for templated hardware and electronic hardware using templates provided by finish hardware supplier. Reinforce frames for surface mounted hardware.
- .6 Prepare frames to receive electrical conduit for door operators where indicated and required.
- .7 Protect mortised cutouts with steel guard boxes.
- .8 Provide anchorage appropriate to floor, wall and frame construction. Each wall anchor shall be located immediately above or below each hinge reinforcement on the hinge jamb and directly opposite on the strike jamb. For rebate opening heights up to and including 1520 mm provide two (2) anchors, and an additional anchor for each additional 760 mm of height or fraction thereof, except as indicated below. Frames in previously placed concrete, masonry or structural steel shall be provided with anchors located not more than 150 mm from the top and bottom of each jamb, and intermediate anchors at 660 mm on centre maximum. Fasteners for such anchors shall be provided by others.
- .9 Minimum reinforcing, anchor and other component thickness shall be in accordance with Table 1 of the CSDMA, "Recommended Specifications for Commercial Steel Door and Frame Products".
- .10 Each interior door opening shall be prepared for single stud rubber door silencers, three (3) for single door openings, two for double door openings, except on gasketed frame product.
- .11 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.

.2 Welded Type

- .1 Welding in accordance with CSA W59.
- .2 Accurately mitre or mechanically joint frame product and securely weld on inside of profile.
- .3 Cope accurately and securely weld butt joints of mullions, centre rails and sills.
- .4 Grind welded joints and corners to a flat plane, fill with metallic paste and sand to uniform smooth finish.
- .5 Where frame product is to be installed prior to the adjacent partition, a floor anchor shall be securely attached to the inside of each jamb profile. Each floor anchor shall be provided with two holes for securing to the floor. For conditions that do not permit the use of a floor anchor, an additional wall anchor, located within 150 mm of the base of the jamb, shall be substituted.
- .6 Weld in two temporary jamb spreaders per door opening to maintain proper alignment during shipment and handling, which shall not be used for installation.
- .7 Glazing stops shall be formed steel channel, minimum 16 mm height, accurately fitted, butted at corners and fastened to frame sections with counter-sunk oval head sheet metal screws.
- .8 When required due to site access, when advised by the contractor responsible for coordination or installation, as specified on the drawings or due to shipping limitations, frame product for large openings shall be fabricated in sections as designated on the approved submittal drawings, with splice joints for field assembly and welding by others.
- .9 Prior to shipment, mark each frame product with an identification number as shown on the approved submittal drawings.
- .10 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.
- .11 Manufacturer's nameplates on frames and screens are not permitted

2.5 Fabrication - Doors

.1 General

- .1 Interior doors: insulated steel construction with honeycomb core laminated to minimum 1.19 mm nominal thickness steel face sheets under pressure.
- .2 Voids between vertical stiffeners shall be filled with fiberglass batt type insulation.
- .3 Doors: swing type, flush.

- .4 Doors: manufacturers' proprietary construction, tested and/or engineered as part of a fully operable assembly, including door, frame, gasketing and hardware in accordance with ASTM E330.
- .2 Longitudinal edges shall be mechanically inter-locked, adhesive assisted. Seams: visible grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish.
- .3 Doors shall be mortised, blanked, reinforced, drilled and tapped at the factory for templated hardware and electronic hardware, in accordance with the approved hardware schedule and templates provided by the hardware supplier.
- .4 Holes 12.7 mm diameter and larger shall be factory prepared, except mounting and through-bolt holes, which are by others, on site, at time of hardware installation. Holes less than 12.7 mm diameter shall be factory prepared only when required for the function of the device (for knob, lever, cylinder, thumb or turn pieces) or when these holes over-lap function holes.
- .5 Doors shall be reinforced where required, for surface mounted hardware, anchor hinges, thrust pivots, pivot reinforced hinges, or non-templated hardware.
- .6 Provide top and bottom of doors with inverted, recessed, welded steel channels. Exterior doors shall be provided with rigid PVC top caps.
- .7 Minimum reinforcing and component thickness shall be in accordance with Table 1 of the CSDMA, "Recommended Specifications for Commercial Steel Door and Frame Products".
- .8 Provide factory-applied touch-up primer at areas where zinc coating has been removed during fabrication.
- .9 Prior to shipment, mark each door with an identification number as shown on the approved submittal drawings.
- .10 Manufacturer's nameplates on doors are not permitted.

2.6 Glazing Stops

- .1 Glazing stops shall be accurately fitted, butted at corners with removable stops located on push side of door.
- .2 Provide tamper proof screws on all doors and screens.

2.7 Finishes

- .1 Doors and frames shall wipe coat zinc, ready for painting.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.2 Installation

- .1 Install doors and frames to CSDMA Installation Guide, NAAMM-HMMA 840, Installation Guide for Commercial Steel Doors and Frames.
- .2 Install doors and hardware in accordance with hardware templates and manufacturer's instructions and Section 08 71 10 - Door Hardware. Coordinate with Section 08 71 10 for preparation and installation of automatic door operators.
- .3 Adjust operable parts for correct clearances and function.
- .4 Install door silencers.
- .5 Provide even margins between doors and jambs and doors and finished floor and thresholds as follows:
 - .1 Hinge side: 1.0 mm.
 - .2 Latch side and head: 1.5 mm.
 - .3 Finished floor and thresholds: 13 mm.
- .6 Caulk perimeter of frames. Refer to Section 07 92 00 – Joint Sealants.

3.3 Finish Repairs

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

3.4 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 06 20 00 Finish Carpentry
- .2 Section 08 11 00 Metal Doors and Frames

1.3 References

- .1 American National Standards Institute (ANSI) / Builders Hardware Manufacturers Association (BHMA)
 - .1 ANSI/DHI A115.1G-1994 Installation Guide for Doors and Hardware
 - .2 ANSI/ICC A117.1-2017 Accessible and Usable Buildings and Facilities
 - .3 ANSI/BHMA A156.1-2013 American National Standard for Butts and Hinges.
 - .4 ANSI/BHMA A156.2-2011 Bored and Preassembled Locks and Latches.
 - .5 ANSI/BHMA A156.4-2013 Door Controls - Closers.
 - .6 ANSI/BHMA A156.5-2014 Auxiliary Locks and Associated Products.
 - .7 ANSI/BHMA A156.6-2010 Architectural Door Trim.
 - .8 ANSI/BHMA A156.8-2010 Door Controls - Overhead Stops and Holders.
 - .9 ANSI/BHMA A156.10-2011 Power Operated Pedestrian Doors.
 - .10 ANSI/BHMA A156.12-2013 Interconnected Locks and Latches.
 - .11 ANSI/BHMA A156.13-2012 Mortise Locks and Latches Series 1000.
 - .12 ANSI/BHMA A156.15-2011 Release Devices - Closer Holder, Electromagnetic and Electromechanical.
 - .13 ANSI/BHMA A156.18-2012 Materials and Finishes.
 - .14 ANSI/BHMA A156.19-2013 Power Assist and Low Energy Power - Operated Doors.
- .2 Canadian Steel Door Manufacturers' Association (CSDMA)
 - .1 CSDMA Canadian Metric Guide for Steel Doors and Frames (Modular Construction): Standard Hardware Location Dimensions.
- .3 Door Hardware Institute (DHI)
- .4 Accessibility for Ontarians with Disabilities Act (AODA)

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: Submit manufacturer's printed product literature, specifications and data sheets.
- .3 Samples:
 - .1 Identify each sample by label indicating applicable specification paragraph number, brand name and number, finish and hardware package number.
 - .2 After approval samples will be returned for incorporation in the Work.
- .4 Hardware List:
 - .1 Submit contract hardware list.
 - .2 Indicate specified hardware, including make, model, material, function, size, finish and other pertinent information.
- .5 Manufacturer's Instructions: Submit manufacturer's installation instructions.

- .6 Provide operation and maintenance data for door closers, locksets, door holders and electrified hardware for incorporation into Operations and Maintenance Manuals specified in Section 01 78 00 - Closeout Submittals.

1.5 Quality Assurance

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

1.6 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.
- .3 Package each item of hardware including fastenings, separately or in like groups of hardware, label each package as to item definition and location.
- .4 Receive the delivery of the Finishing Hardware and identify all items against the Finishing Hardware Schedule. Ensure each hardware item is accompanied by the correct template, installation instructions, special tools, fastening devices and other loose items. Advise the finish hardware supplier and Consultant in writing of errors or omissions.
- .5 Storage and Protection: Store finishing hardware in locked, clean and dry area.
- .6 Remove all hardware from doors and frames prior to painting. After painting is complete and dry, reinstall all hardware to manufacturer's recommendations.

1.7 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

1.8 Warranty

- .1 Warrant all hardware against defects of workmanship and material, for a period of one year, except for door closers which shall be warranted for ten years from the date of Substantial Performance and agree to make good promptly any defects which occur or become apparent within the warranty period.

PART 2 PRODUCTS

2.1 Materials

- .1 All hardware shall be supplied as specified in the Finishing Hardware Schedule.
- .2 All finishes shall be as indicated in the Finishing Hardware Schedule by international codes.
- .3 All door handles shall be lever type meeting requirements of the referenced accessibility standards and the Ontario Building Code.

- .4 Power Door Operators and controls shall be CSA approved and shall meet the requirements of the Ontario Building Code and the Accessibility for Ontarians with Disabilities Act (AODA).

2.2 Fastenings

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

2.3 Keying

- .1 Keying: All permanent cylinders to be grandmaster-keyed as directed by the Owner. The factory shall key all locks and cylinders and maintain keying records. The factory shall establish a System Information Document (SID) to designate primary system administrators and require a separate letter of authorization for all future shipments of keyed products.
- .2 Remove all construction cores and install all permanent cores. Unless otherwise directed by the Owner.
- .3 Construction master/change keys are to be delivered by the Contractor directly to The Owner.
- .4 Ship all permanent cylinders and keys separately. Identify door number and keyset symbol on each envelope for direct factory delivery to the owner.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Furnish metal door and frame manufacturers with complete instructions and templates for preparation of their work to receive hardware.
- .3 Furnish manufacturers' instructions for proper installation of each hardware component.

3.2 Examination

- .1 Before installing any hardware, carefully check all architectural drawings of the work requiring hardware, verify door swings, door and frame materials and operating conditions, and assure that all hardware will fit the work to which it is to be attached.

- .2 Check all shop drawings and frame and door lists affecting hardware type and installation, and certify to the correctness thereof, or advise the hardware supplier and Consultant in writing of required revisions.

3.3 Templates

- .1 Check the hardware schedule, drawings and specifications, and furnish promptly to the applicable trades any patterns, templates, template information and manufacturer's literature required for the proper preparation for and application of hardware, in ample time to facilitate the progress of the work.

3.4 Installation

- .1 Installation of hardware shall be in accordance with ANSI A115.1G, manufacturer's templates and instructions.
- .2 Install each item of mechanical and electromechanical hardware and access control equipment to comply with the manufacturer's written instructions and according to specifications. All items to be installed with fasteners identified by manufacturer's installation instructions unless otherwise noted.
- .3 Mounting Heights: Install door hardware at heights indicated in the following applicable publications unless; specifically indicated or required by local governing regulations, requirements to match for special templates, necessary coordination with door elevations, and or to ensure consistency with pairs of doors.
 - .1 DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames"
 - .2 DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors"
 - .3 ANSI/ICC A117.1 Accessibility Guidelines for Buildings and Facilities
 - .4 NWWDA
 - .5 AODA
- .4 Power door operator products and accessories are required to be installed by an AAADM certified technician as approved by the manufacturer. Adjust for proper opening and closing operation after final balancing of HVAC system.
- .5 Coordinate installation of electric door strikes, keypad locks, card readers, washroom duress systems, and other electronic door control and security devices with Electrical contractor including supply and installation of wiring and all terminations.
- .6 All hardware shall be installed by carpenters, skilled in the application of architectural hardware and satisfactory to the hardware supplier. Refer to Section 06 20 00 - Finish Carpentry. Instruction sheets, details and templates shall be read and understood before installation.
- .7 Install all materials as listed in the Finishing Hardware Schedule on the doors and frames listed. Interchanging of hardware will not be allowed.
- .8 Use only manufacturer's supplied fasteners. Failure to comply may void manufacturer's warranties and applicable licensed labels. Use of "quick" type fasteners, unless specifically supplied by manufacturer, is unacceptable.
- .9 Where door stop contacts door pulls, mount stop to strike bottom of pull.
- .10 Remove construction cores when directed by Owner's Representative.

- .11 After installation, templates, installation instructions and details shall be put in a file and turned over to the Owner, when building is Substantially Performed.

3.5 Field Quality Control

- .1 Conduct periodic inspections to ensure that door frames are installed plumb, level and square with verification by installer prior to installation of doors and door hardware.
- .2 Hardware supplier to attend site meetings as required to ensure proper execution of the guidelines set forth herein.
- .3 Hardware supplier will perform final field inspection of installed door hardware after final adjustment of all products and will document and report any deficiencies or omissions for correction and written acceptance by the Contractor.

3.6 Adjusting

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

3.7 Demonstration

- .1 Instruct Owner's maintenance personnel in the proper adjustment, operation and maintenance of mechanical and electromechanical door hardware, electronic devices and maintenance of finishes.

3.8 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .3 Clean hardware with damp rag and approved non-abrasive cleaner, and polish hardware in accordance with manufacturer's instructions.
- .4 Remove protective material from hardware items where present.

End of Section

Rivett Architectural Hardware Ltd.

Door Listing

BROCK H.S - WASHROOM RENOV. - REG.ROAD 12, CANNINGTON, ON

Schedule 200820
Date Apr 20/26

Door Number	Set Number
318	1
320A	2
320B	2
320C	2
320D	2
320E	2
326	3
328	2
328A	2
328B	2
328C	2
328D	2
342	4
361A	5

Rivett Architectural Hardware Ltd.

Hardware Schedule

BROCK H.S - WASHROOM RENOV. - REG.ROAD 12, CANNINGTON, ON

Schedule 200820
Date Apr 20/26

Set # 1

1 SGLE. DR. # 318 EXISTING CORRIDOR TO LAUNDRY ROOM 318

RH

1 - 965 x 2134 x 45 x PSF x HMD x 45 MIN RATED

Qty

:	:	3 EA	HINGE	BB1168-114 X 101- 626
:	:	1 EA	CLASSROOM LOCK	L9070P X 03B X 626
:	:	1 EA	CLOSER	4040XP X 689
:	:	1 EA	WALL STOP	232W X 626
:	:	1 EA	KICKPLATE	190S X 203 X 914 X 630

Set # 2

1 SGLE. DR. # 320A WASHROOM LOBBY TO G/N WASHROOM 320A

LH

1 SGLE. DR. # 320B WASHROOM LOBBY TO G/N WASHROOM 320B

LH

1 SGLE. DR. # 320C WASHROOM LOBBY TO G/N WASHROOM 320C

RH

1 SGLE. DR. # 320D WASHROOM LOBBY TO G/N WASHROOM 320D

RH

1 SGLE. DR. # 320E WASHROOM LOBBY TO G/N WASHROOM 320E

RH

1 SGLE. DR. # 328 WASHROOM LOBBY TO G/N WASHROOM 328

RH

1 SGLE. DR. # 328A WASHROOM LOBBY TO G/N WASHROOM 328A

RH

1 SGLE. DR. # 328B WASHROOM LOBBY TO G/N WASHROOM 328B

RH

1 SGLE. DR. # 328C WASHROOM LOBBY TO G/N WASHROOM 328C

LH

1 SGLE. DR. # 328D WASHROOM LOBBY TO G/N WASHROOM 328D

RH

10 - 762 x 2134 x 45 x PSF x HMD

Qty

:	:	33 EA	HINGE	BB1168-114 X 101- 626
:	:	10 EA	ENTRANCE LOCK C/W INDICATOR	L9056P-03B-XL13-439-OS-OCC-626
:	:	10 EA	CLOSER	4040XP X 689
:	:	10 EA	WALL STOP	232W X 626
:	:	10 EA	SWEEP	W24S X 3'-0" X 628
:	:	10 EA	KICKPLATE	190S X 203 X 711 X 630
:	:	10 EA	WALL BOXES WITH COVERS	FUTURE USE
:	:	10 EA	CONDUIT WITH PULL STRINGS	FUTURE USE
CONDUIT & WALL BOXES TO BE ROUGH IN ONLY FOR FUTURE USE				

Rivett Architectural Hardware Ltd.

Hardware Schedule

BROCK H.S - WASHROOM RENOV. - REG.ROAD 12, CANNINGTON, ON

Schedule 200820
Date Apr 20/26

Set # 3

1 SGLE. DR. # 326 SPECIAL ED. CLASSROOM TO OFFICE 326

RH

1 - MATCH EXISTING x MATCH EXISTING x 45 x EXIST. FRAME x NEW WD

Qty

:	:	3 EA	HINGE	BB1279-114 X 101- 626
:	:	1 EA	OFFICE LOCK	L9050P X 03B X 626
:	:	1 EA	WALL STOP	232W X 626
:	:	1 EA	KICKPLATE	190S X 203 X EXIST WIDTH X 630

Set # 4

1 SGLE. DR. # 342 CORRIDOR 360 TO UNIVERSAL WASHROOM 342

RH

1 - EXISTING FRAME & DOOR REMAIN

Qty

:	:	1 EA	EXISTING HARDWARE	EXISTING HARDWARE REMAINS

Set # 5

1 SGLE. DR. # 361A MECHANICAL ROOM 361 TO MECHANICAL TUNNEL 361A LH

1 - 965 x 1650 x 45 x PSF x HMD x 45 MIN RATED

Qty

:	:	3 EA	HINGE	BB1168-114 X 101- 626
:	:	1 EA	STOREROOM LOCK	L9080P X 03B X 626
:	:	1 EA	CLOSER	4040XP X 689
:	:	1 EA	KICKPLATE	190S X 203 X 914 X 630

BB1168

BB1168



SPECIFICATIONS

Applications	For use on heavy weight doors and doors requiring high frequency service
Box Quantity	3
Case Quantity	24
Certifications	ANSI A8111
Electric Modifications	EMN (Electric Monitor Only), ETW (Electric Through-Wire Only), ETM (Electric Through-Wire with Monitoring), Quick Connect
Features	• Four ball bearings • Removable or non-removable pin with button tip and plug • Available in two different leaf sizes
Finishes	• LS, USP, US3, US10, US10A, US10B, US15, US26, US26D • Additional finishes may be available, please contact Hager for availability and lead time.
Fire Rating	Complies with NFPA80 requirements for use on fire rated door assemblies
Gauge	See Sizing Chart Options
Height	See Sizing Chart Options
Knuckles	5
Material	Steel with Steel Pin
Options	• Stamped with UL logo when ordered for export • Unequal top/bottom available in non-removable or removable pin
Product Description	Full Mortise, Ball Bearing, Heavy Weight
Width	See Sizing Chart Options

BB1279

Product Information

- Description:**
- ANSI A8112
 - Two ball bearings
 - Non-rising removable pin with button tip and plug
 - 5" x 5" (217 mm x 127 mm) and 4 1/2" x 4-1/2" (114 x 114 mm) available with two different leaf sizes
 - 3-1/2" x 3-1/2" (89 mm x 89mm) available with reversible hole pattern
 - For use on medium weight doors or doors requiring medium frequency service

- Note:**
- Complies with NFPA80 requirements for use on fire rated door assemblies

Five Knuckle- Ball Bearing- Standard Weight



Product Specifications

Material: - Steel with Steel pin

Finishes: - LS, H2H, USP, US3, US4, US10, US10A, US10B, US15, US26,

Product Size Options

Hinge Size (inches)	Hinge Size (mm)	Gauge of Metal	Hole Count	Screw Size (Machine)	Screw Size (Wood)
3 1/2 x 3 1/2	89 x 89	0.119	6	1/2 x 10-24	1 x 9
4 x 4	102 x 102	0.129	8	1/2 x 12-24	1 1/4 x 12
4 1/2 x 4	114 x 102	0.134	8	1/2 x 12-24	1 1/4 x 12
4 1/2 x 4 1/2	114 x 114	0.134	8	1/2 x 12-24	1 1/4 x 12
5 x 4	127 x 102	0.145	8	1/2 x 12-24	1 1/4 x 12
5 x 4 1/2	127 x 114	0.145	8	1/2 x 12-24	1 1/4 x 12
5 x 5	127 x 127	0.145	8	1/2 x 12-24	1 1/4 x 12
6 x 4-1/2	152 x 114	0.160	10	1/2 x 1/4-20	1 1/2 x 14
6 x 5	152 x 127	0.160	10	1/2 x 1/4-20	1 1/2 x 14
6 x 6	152 x 152	0.160	10	1/2 x 1/4-20	1 1/2 x 14



L Series

Grade 1, Mortise Locks

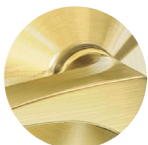
OVERVIEW

The Schlage® L Series has long been the benchmark for Grade 1 mortise locks. Beyond strength and security—it offers flexibility to meet most needs. 67 mechanical functions include ten non-levered small- and large-case deadbolt functions and 15 electrified functions regularly used as part of electronic access control systems, six of which feature motorized latch retraction. L Series locks have the ability to suite across electronic, tubular, exit trim, and multi-point locks to integrate seamlessly into any environment. The series features an array of security options including patented, 180-degree high visibility lock status indication trim, key override of a thumbturn being held, and support for multiple keyway families and cylinder types including Primus® XP high-security cylinders.

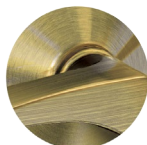
FINISHES



605
Bright Brass



606
Satin Brass



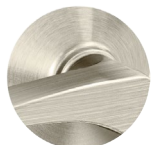
609
Antique Bronze



612¹
Satin Bronze



613¹
Oil Rubbed
Bronze



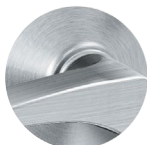
619
Satin Nickel



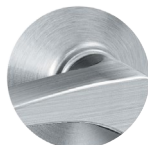
622
Matte Black



625
Bright Chrome



626
Satin Chrome



626AM
Satin Chrome
Antimicrobial



629²
Bright Stainless
Steel



630²
Satin Stainless
Steel



630AM²
Satin
Stainless Steel
Antimicrobial



643e
Aged Bronze



1. Available on standard levers only, not available on Latitude, Longitude, Accent, Asti, or Merano.

2. Not available on Accent, Asti, or Merano.

STANDARD LEVER AND KNOB STYLES



01
801 - Milled tactile warning



02
802 - Knurled tactile warning¹



03 (Tubular)
803 - Knurled tactile warning¹



05
805 - Milled tactile warning



06 (Rhodes)
806 - Milled tactile warning



07 (Athens)
807 - Milled tactile warning



12
812 - Milled tactile warning
Handed



17 (Sparta)
817 - Milled tactile warning

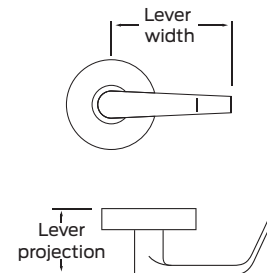


18
818 - Milled tactile warning

Dimensions

Lever	Width	Projection
01	3.88"	2.69"
02	4.75"	2.81"
03 (Tubular)	4.75"	2.81"
05	3.75"	2.88"
06 (Rhodes)	4.63"	2.5"
07 (Athens)	4.63"	2.88"
12	4.63"	3.06"
17 (Sparta)	4.75"	3"
18	4.88"	2.69"

Return to door meets 1/2" requirement for 03, 06 and 17 levers.



¹. Knurled tactile warning available on 609, 612, 613, 625, 626, 629, and 630 finishes only.

Note: Images shown with Schlage L mortise 'A' rose; additional rose and escutcheon designs available.

ESCUTCHEONS



L full face
Specify by adding 'L' after lever design.

Finishes: available in all L Series finishes.



L concealed
Specify by adding 'C' suffix to function and by adding 'L' after lever design.

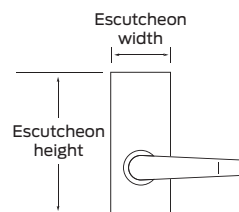
Finishes: available in all L Series finishes.



N full face
Specify by adding 'N' after lever design.

Finishes: available in all L Series finishes.

Escutcheon	Width	Height
L full face	1.75"	7.938"
L concealed	1.75"	7.938"
N full face	2.5"	7.875"



ROSES



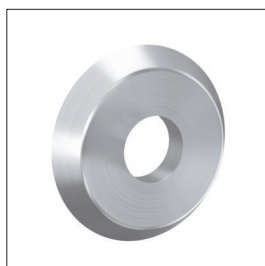
A rose
Available for use on L Series knob and lever designs. Specify by adding 'A' after lever design.

Finishes: available in all L Series finishes.



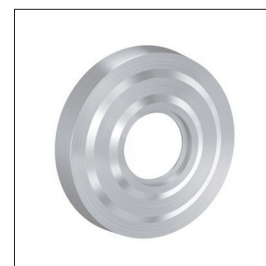
B rose
Available for use on L Series knob and lever designs. Specify by adding 'B' after lever design.

Finishes: available in all L Series finishes.



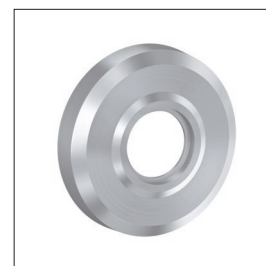
C rose
Available for use on L Series knob and lever designs. Specify by adding 'C' after lever design.

Finishes: 605, 606, 609, 619, 622, 625, 626, 629, 630, 643e.



AVA rose
Available for use with AST lever only. Specify as ASTAVA.

Finishes: 605, 606, 609, 619, 622, 625, 626, 643e.



MER rose
Available for use with MER lever only. Specify as MERMER.

Finishes: 605, 606, 609, 619, 622, 625, 626, 643e.

Rose	Diameter
A	2.125"
B	2.562"
C	2.625"
AVA	2.625"
MER	2.625"



THUMBTURNS



ADA thumbturn (standard)
09-544



Large ADA thumbturn
09-509 x L583-363
Not available with L9463 and L463



Basic thumbturn

INDICATORS

Inside Trims



Thumbturn



Key cylinder



Standard for lock functions L9486, L9496 and L496, used with A or B roses only. Available messages: "OCCUPIED", "DO NOT DISTURB" or "LOCKED".

Outside Trims



Emergency key



Coin turn



Key cylinder

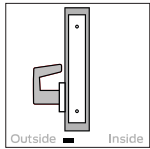
Available messages				
	LOCKED	OCCUPIED	DO NOT DISTURB	
	UNLOCKED	VACANT		
Inside trim	IS-LOC	IS-OCC	IS-DND	IS-SYM
Outside trim	OS-LOC	OS-OCC	OS-DND	OS-SYM
Inside trim	IS-LOCFR	IS-OCCFR	–	–
Outside trim	OS-LOCFR	OS-OCCFR	–	–

Note: Spanish language options available via RFQ.

Dimensions		
	Width	Height
Escutcheon	2.6"	9.7"
Sectional	2.6"	6.1"
Main window	2"	0.6"
Side windows	0.3"	0.6"

Non-Keyed Dummy Functions

Schlage L9175



**Half dummy trim
with lock case**

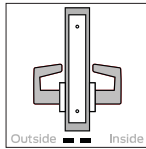
- Lever (or knob) only-one side; blank armor front without latchbolt
- Lever always fixed

Note: Includes blank armor front and lock case.

Door handing must be specified. May be ordered with optional XL11-743 armor front with cutout to receive deadbolt.

ANSI -

Schlage L9176



**Full dummy trim
with lock case**

- Levers (or knobs) only-both sides; blank armor front without latchbolt
- Both levers always fixed

Note: Includes blank armor front and lock case.

May be ordered with optional XL11-743 armor front with cutout to receive deadbolt.

Ordering: In a double-door application where dummy is used as the strike, order 10-091 armored front strike separately.

ANSI -

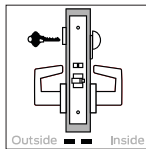
Single Cylinder Non-Deadbolt Functions

The L Series offers a multitude of functional options. But among them, the L9050 basic entrance/office function, is perhaps the most versatile in its ability to be transformed for other uses. With a few part changes this lock can be transformed into these functions:

- L9010** Passage latch
- L9025** Exit or communicating lock
- L9026** Exit lock with cylinder
- L9060** Apartment entrance lock
- L9070** Classroom lock, exterior lockdown only
- L9071** Classroom security lock, interior/exterior lockdown
- L9080** Storeroom lock

To learn more, reference the [L Series Universal Transformation Guide](#).

Schlage L/LV9050



Entrance/office lock

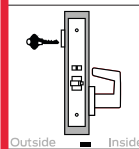
- Key cylinder outside; thumbturn inside; latchbolt and deadlocking auxiliary latch
- Latchbolt retracted by lever (or knob) from either side
- Outside lever is made inoperative by key outside or by turning inside thumbturn; Vandlgard® option allows both levers to rotate freely down while locked
- Key outside unlocks outside lever and retracts latchbolt
- Rotating inside thumbturn unlocks outside lever; turning inside lever retracts latchbolt but does not unlock
- Inside lever always free for immediate egress

Caution: Egress without fully rotating the thumbturn to vertical position can result in lock-out situations.

Note: Hospital latch and ligature-resistant trims not available with Vandlgard option.

ANSI F04

Schlage L9026



Exit lock with cylinder

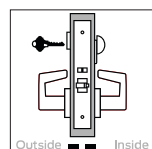
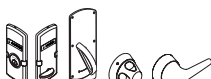
- Key cylinder only, no lever (or knob) outside; lever only-inside; latchbolt and deadlocking auxiliary latch
- Latchbolt retracted by lever from inside
- Key outside retracts latchbolt
- Inside lever always free for immediate egress

Note: Available in rose or L escutcheon trim only. When ordering, specify door handing.

ANSI -

Mechanical Lock Functions

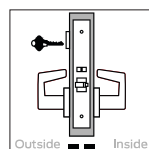
Single Cylinder Non-Deadbolt Functions

Schlage**L/LV9056****L/LV9056 with XL13-439****ANSI****Entrance/office lock with automatic unlocking**

- Key cylinder outside; thumbturn inside; latchbolt and deadlocking auxiliary latch
- Latchbolt retracted by lever (or knob) from either side
- Outside lever is made inoperative by key outside or by turning inside thumbturn; Vandlgard® option allows outside lever to rotate freely down while locked
- Key outside unlocks outside lever and retracts latchbolt; XL13-439 option also allows key override of thumbturn if being held in locked position
- Rotating inside thumbturn unlocks outside lever; turning inside lever retracts latchbolt and unlocks outside lever; closing door also unlocks preventing lock-out
- Inside lever always free for immediate egress

Note: Ligature-resistant trims not available with Vandlgard option.

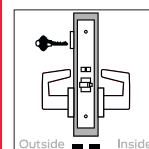
To order with key override, specify function and note XL13-439 as a special option.

Schlage**L/LV9070****ANSI****F05****Classroom lock, exterior lockdown only**

- Key cylinder outside with lever (or knob); lever only-inside; latchbolt and deadlocking auxiliary latch
- Latchbolt retracted by lever from either side
- Outside lever is made inoperative by key outside; Vandlgard® option allows outside lever to rotate freely down while locked
- Key outside unlocks outside lever and retracts latchbolt
- Inside lever always free for immediate egress

Note: Outside lever remains inoperative until unlocked by key.

Note: Hospital latch and ligature-resistant trims not available with Vandlgard option.

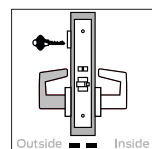
Schlage**L/LV9076****ANSI****F06****Classroom holdback lock, exterior lockdown only**

- Key cylinder outside with lever (or knob); lever only-inside; latchbolt and deadlocking auxiliary latch
- Latchbolt retracted by lever from either side
- Outside lever is made inoperative by key outside; Vandlgard® option allows outside lever to rotate freely down while locked
- Key outside unlocks outside lever and retracts latchbolt
- Rotate inside lever while turning key 360° to activate retracted latch holdback feature; to deactivate, reverse key rotation 360°
- Inside lever always free for immediate egress

Note: Outside lever remains inoperative until unlocked by key.

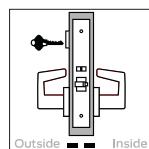
Note: Locks with holdback feature are not UL listed. Installation should be in accordance with existing codes only.

Note: Ligature-resistant trims not available with Vandlgard option.

Schlage**L/LV9080****ANSI****F07****Storeroom lock**

- Key cylinder outside with lever (or knob); lever only-inside; latchbolt and deadlocking auxiliary latch
- Outside lever always fixed; latchbolt retracted by inside lever; Vandlgard® option allows outside lever to rotate freely down while locked
- Key outside retracts latchbolt
- Inside lever always free for immediate egress

Note: Hospital latch and ligature-resistant trims not available with Vandlgard option.

Schlage**L/LV9081****ANSI****-****Accessible storeroom lock**

- Key cylinder outside with lever (or knob); lever only-inside; latchbolt and deadlocking auxiliary latch
- Latchbolt retracted by lever from either side
- Outside lever is made inoperative by key outside; Vandlgard® option allows outside lever to rotate freely down while locked
- Key outside inserted and turned 280° unlocks allowing outside lever to retract latchbolt
- Inside lever always free for immediate egress

When ordering, specify door handing.

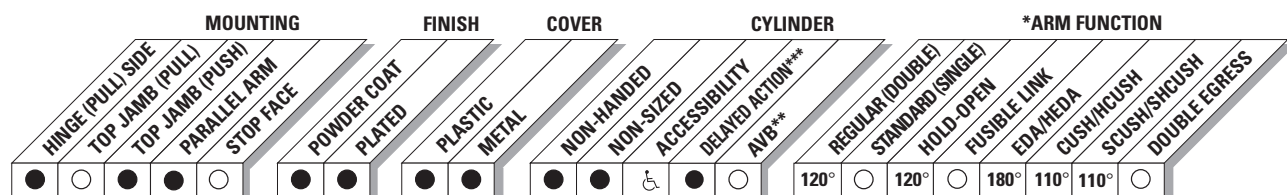


The 4040XP is LCN's most durable and flexible heavy duty closer designed for institutional and other demanding high traffic applications.

Certifications	Grade 1 - ANSI A156.4, UL 10C, ADA, 100 Hour Salt Spray, Meets BAA - Buy American Act	Cover	■ Plastic, Standard ■ Metal, Optional
Body Construction	■ Cast Iron Body ■ Full Complement Bearings ■ 1-1/2" Diameter Piston ■ 3/4" Diameter Double Heat Treated Pinion Journal	Fasteners	Self Reaming and Tapping Screws (SRT)
Fluid	All Weather Liquid X Fluid	Mounting	Hinge (Pull Side), Top Jamb (Push Side), Parallel Arm (Push Side)
Handing	Non-Handed	Arms	Regular Arm
Templating	Peel-n-Stick templates - 2-1/4" x 5" Mounting Hole Pattern	Finishes/Colors/Powder Coat	■ Aluminum (689) ■ Statuary Bronze (690) ■ Light Bronze (691) ■ Black (693) ■ Dark Bronze (695) ■ Brass (696) ■ Custom colors optional
Size	Adjustable Spring Size 1-6, includes Patented Green Dial		■ Optional SRI primer - powder coat only ■ Optional plated finishes
Warranty	30 years		

Special Templates

Customized installation templates or products may be available to solve unusual applications. Contact LCN Product Support for assistance.



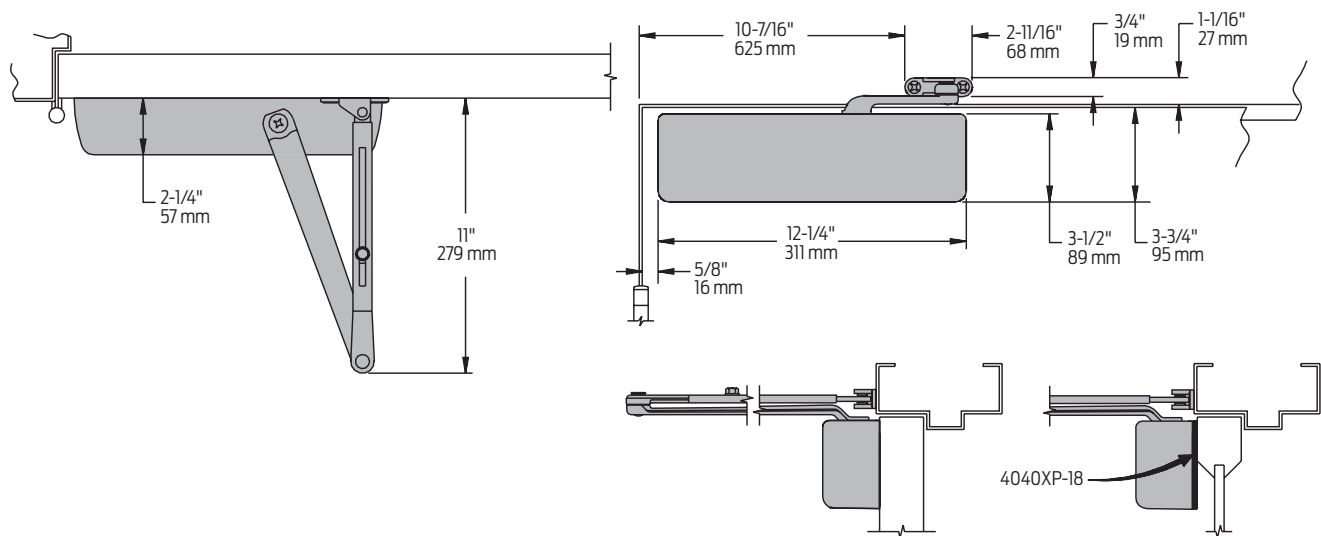
● AVAILABLE
○ NOT AVAILABLE

⦿ Closer available with less than 5.0 lbs. opening force on 36" door.
* Maximum opening/hold-open point with standard template.
** Advanced Variable Backcheck.
*** Delay feature incorporates standard 4040 cylinder (not XP).

4040XP Series

Mounting details

Hinge (Pull Side) Mounting

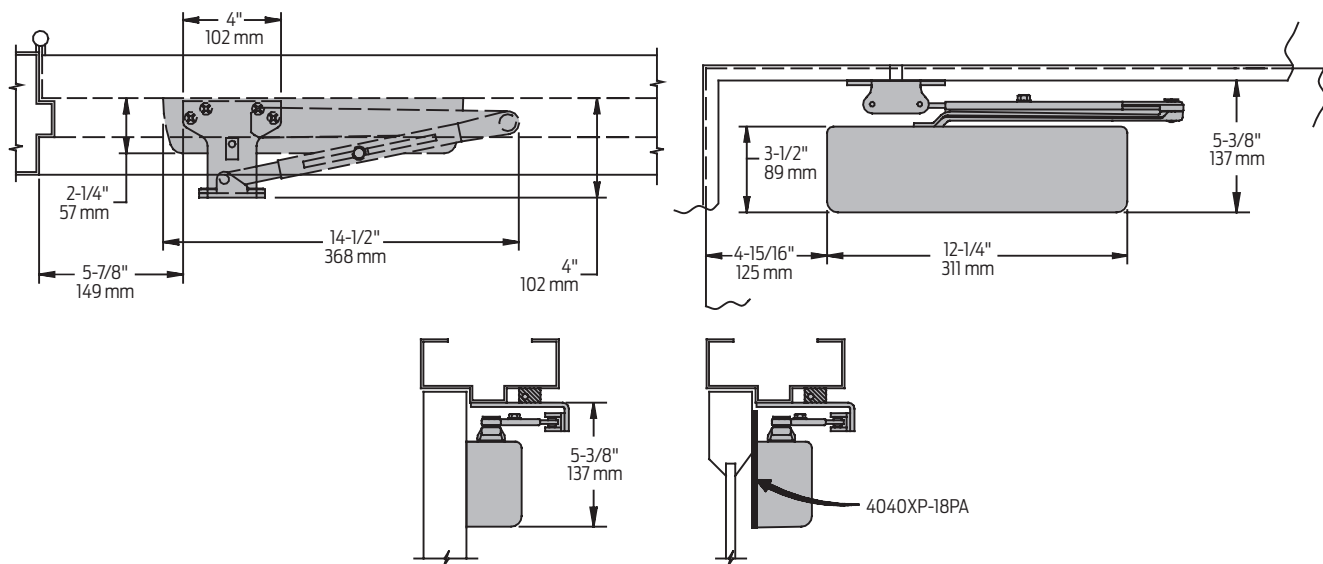


Butt Hinges	Should not exceed 5" (127 mm) in width
Auxiliary Stop	Recommended at hold-open point or where a door cannot swing beyond 120°
Reveal	Should not exceed 3/4" (19 mm) for regular arm or hold-open arm
Top Rail	Less than 3-3/4" (95 mm) requires PLATE, 4040XP-18. Plate requires 2" (51 mm) minimum
Clearance	2-3/8" (60 mm) behind door required for 90° installation
Delayed Action	- Incorporates standard 4041 cylinder, without XP cylinder - Delays closing from 120° to 70° - Delay time adjustable up to approximately 1 minute
Maximum Opening	- Templating allows up to 120°. - Hold-open points 90° up to 120° with hold-open arm.

4040XP Series

Mounting details

Parallel Arm (Push Side) Mounting



Butt Hinges	Should not exceed 5" (127 mm) in width
Auxiliary Stop	Recommended at hold-open point, where the door cannot swing 180°, or where CUSH-N-STOP arm is not used
Reveal	Should not exceed 7/32" (6 mm)
Top Rail	Less than 5-3/8" (137 mm) measured from the stop requires PLATE, 4040XP-18PA. Plate requires 2" (51 mm) minimum from the stop
Head Frame	Flush or rabbeted requires PA SHOE ADAPTER, 4040XP-419
Stop Width	Minimum 1" (25 mm). CUSH arm requires minimum 1-1/2" (38 mm)
Blade Stop	Clearance requires 1/2" (13mm) BLADE STOP SPACER, 4040XP-61.
Clearance	4040XP-62PA shoe is 4" (102 mm) from door face. - EDA shoe projects 5-1/2" (140 mm) from door face. - CUSH shoe projects 6" (152 mm) from door face
Delayed Action	- Incorporates standard 4041 cylinder, without XP cylinder - Delays closing from 120° to 70°. - Delay time adjustable up to approximately 1 minute.
Maximum Opening	180° opening/hold-open points with all except CUSH arms 110° opening/hold-open with CUSH arms

Notes:

- Optional mounting requires PA SHOE, 4040XP-62PA for regular or HOLD-OPEN arms
- Add prefix "P" to closer description (eg. P4040XP)
- P4040XP closer includes 4040XP-201 FIFTH HOLE SPACER to support PA SHOE

232W

Convex Wall Stop

Notes:

- Specify 232T for machine screw and toggle nut screw pack (10 pk)
- BL232W is 232W case quantity 50
- Concealed tamper proof mounting
- Easy installation by inserting screwdriver through small hole in bumper



PRODUCT SPECIFICATIONS

CERTIFICATIONS:

- Meets ANSI A156.16 for L02101

DIAMETER:

- 2-7/16" (62 mm)

PROJECTION:

- 1" (25 mm)

MATERIALS:

- Wrought brass, bronze, stainless steel with grey rubber bumper

FINISHES:

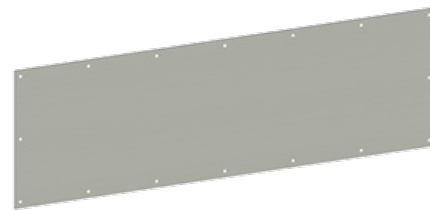
- US3, US4, US5, US9, US10, US10B, US15, US15A, US19, US26, US26D, US32, US32D

FASTENERS:

- One (1) #10 x 1-1/2" PPHWS with plastic and toggle anchor

190S

Door Protection Plate
0.050" gauge with four beveled edges



NFPA Notes:

- NFPA 80 Standards
- 6.4.5 Protection Plates 6.4.5.1
- Factory installed protection plates shall be installed in accordance with the listing of the door. 6.4.5.2
- Field installed protection plates shall be labeled and installed in accordance with their listing. 6.4.5.3
- Labeling shall not be required where the top of the protection plate is not more than 16" (406mm) above the bottom of the door.
- Note: If needing the 190S with rounded corners, please order the 196R.



PRODUCT SPECIFICATIONS

GAUGE:

- 0.050" (1 mm)

MATERIALS:

- Aluminum, Brass, Bronze, **Stainless Steel**

FINISHES:

- US3, US4, US10, US10B, DBZ, US28, US32, US32D

BEVEL:

- 4 edges

ORDER:

- Furnish item #, height, width, and finish (i.e., 190S – 6" x 30", US32D).
- Plates are sized on even inches. Odd size available and priced to next larger size.
- May be ordered with countersunk holes (specify "CSK") at extra charge.

OPTIONS:

- UL listed for US32 and US32D with screw fasteners (must specify UL stamp)
- Self-adhesive tape available on all plates
- Spanner head screws
- Torx head screws
- Round corners - specify 196R
- Wrap around side and bottom return
- 0.125" material

CERTIFICATION:

- Meets ANSI A156.6 for J101 Metal Armor Plate, J102 Metal Kickplate, and J103 Metal Mop Plate

EPD:

- [Door Protection Plates Environmental Product Declaration](#)

PRODUCT SIZE OPTIONS

ITEM #	B&S GAUGE	US GAUGE	BEVEL	FASTENERS	QUANTITY BAG	QUANTITY CASE
190S	16	18	B4E	#6 x 5/8 truss head screws	1 each	---
196R	16	18	none	#6 x 5/8 truss head screws	1 each	---
198S	---	20	none	#6 x 5/8 truss head screws	1 each	---
199B	---	20	none	#6 x 5/8 truss head screws	1 each	---
220S	14	16	B4E	#6 x 5/8 truss head screws	1 each	---

SWEEPS

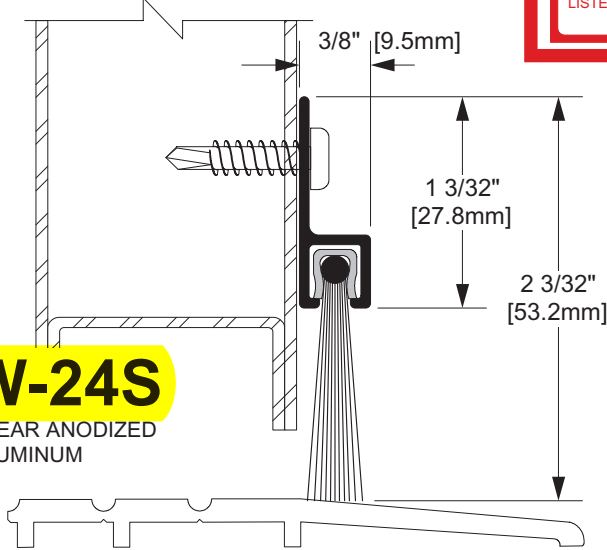


ALL PRODUCTS
ON THIS PAGE

KNC

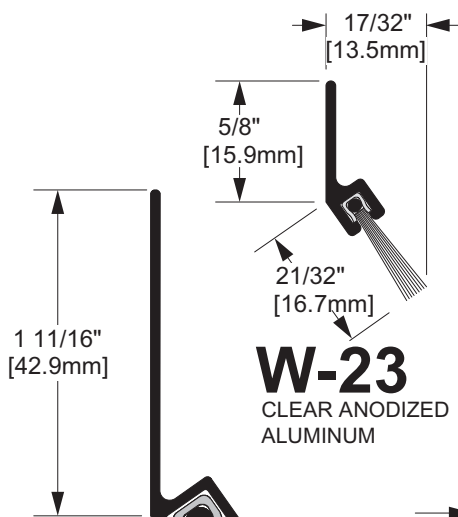
W-24S

CLEAR ANODIZED
ALUMINUM



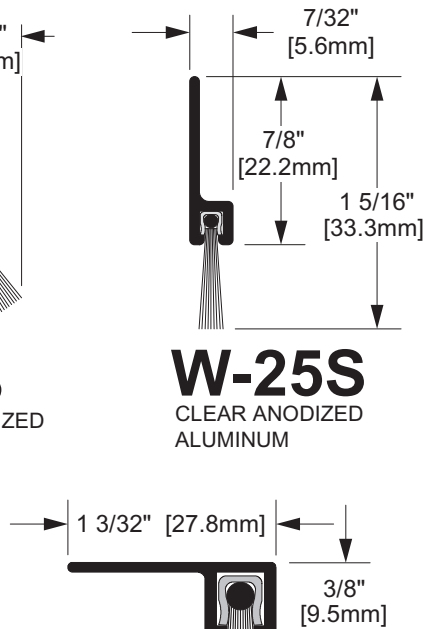
W-23

CLEAR ANODIZED
ALUMINUM



W-25S

CLEAR ANODIZED
ALUMINUM



W-26-1

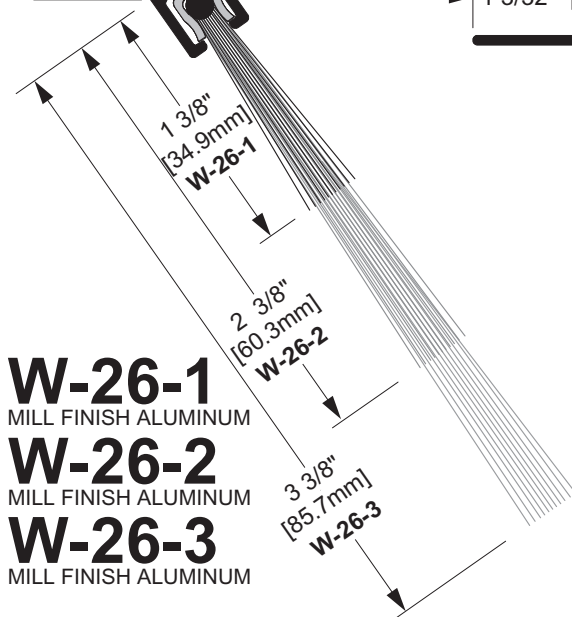
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MILL FINISH ALUMINUM

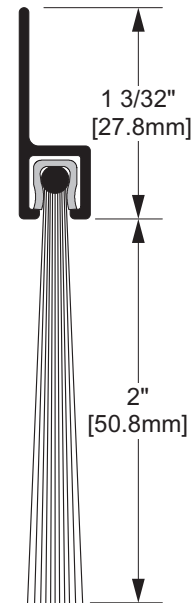
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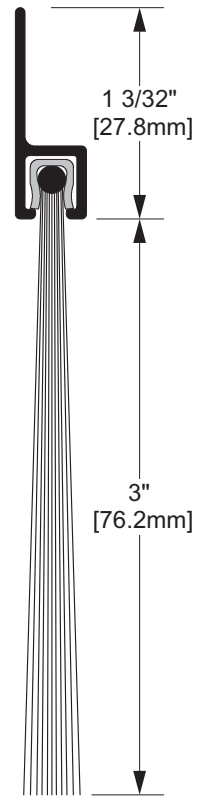
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W-34S

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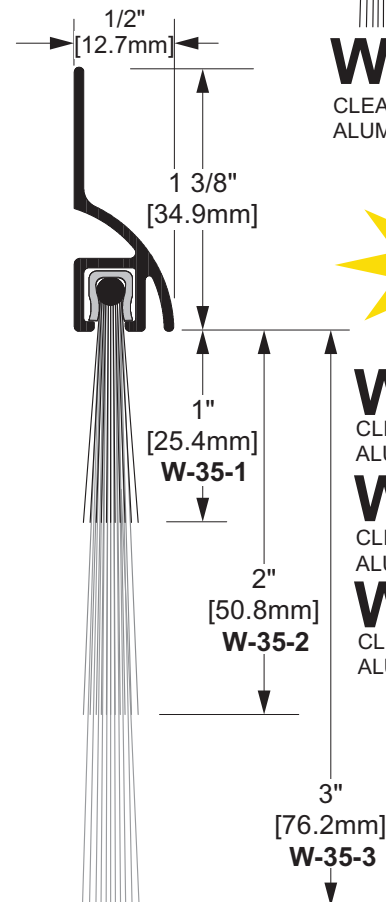
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PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 07 92 00 Joint Sealants
- .2 Section 08 11 00 Metal Doors and Frames
- .3 Section 08 80 05 Glazing

1.3 References

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA 80 - 2022 Standard for Fire Doors and Other Opening Protectives
 - .2 NFPA 252 - 2022 Standard Methods of Fire Tests of Door Assemblies.
 - .3 NFPA 257 - 2022 Standard on Fire Test for Window and Glass Block Assemblies.
- .2 Underwriters Laboratories, Inc. (UL)
 - .1 UL 9 Fire Tests of Window Assemblies.
 - .2 UL 10B for Fire Tests of Door Assemblies.
 - .3 UL 10C Positive Pressure Fire Tests of Door Assemblies.
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S104-15 Standard Method for Fire Tests of Door Assemblies
 - .2 CAN/ULC S106-15 Standard Method for Fire Tests of Window and Glass Block Assemblies
- .4 Consumer Products Safety Commission (CPSC)
 - .1 CPSC 16 CFR 1201 Safety Standard for Architectural Glazing Materials.
- .5 Glass Association of North America (GANA)
 - .1 GANA – Glazing Manual
 - .2 FGMA – Sealant Manual

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings: Submit shop drawings showing layout, profiles and product components.
- .3 Samples: Submit 150 x 150 mm glass samples.
- .4 Product Data: Submit latest edition of manufacturer's product data.
- .5 Provide maintenance data for fire resistant glazing for incorporation into Operation and Maintenance Manual specified in Section 01 78 00 – Closeout Submittals.

1.5 System Description

- .1 Performance Requirements: Provide a fire rating glazing manufactured, fabricated and installed to maintain performance criteria stated by manufacturer without defects, damage or failure.
 - .1 Fire Rating: Fire resistant glazing shall be fire rated from 20-180 minutes with hose stream and is impact safety rated to meet CPSC 16 CFR 1201 Category I and II.
 - .2 Fire resistant glazing shall be tested in accordance with NFPA 80, NFPA 252, NFPA 257, UL 9, UL 10B, UL 10C, ULC 104 and ULC 106.

.3 Testing Laboratory: Fire test shall be conducted by a nationally recognized independent testing laboratory.

.2 Listings and Labels: Fire rated glazing shall be under current follow-up service by a nationally recognized independent testing laboratory approved by OSHA and maintain a current listing or certification. Assemblies shall be labeled in accordance with limits of listings.

1.6 Project Conditions

.1 Field Measurements: Verify actual measurements for openings by field measurements before fabrication. Show recorded measurements on shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

1.7 Shipping, Handling and Storage

.1 Refer to Section 01 61 00 – Common Product Requirements.

.2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

1.8 Waste Management and Disposal

.1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

1.9 Warranty

.1 Warrant the work of this Section against defects of workmanship and material, for a period of five years from the date of Substantial Performance and agree to make good promptly any defects which occur or become apparent within the warranty period.

PART 2 PRODUCTS

2.1 Fire Rated Glazing

.1 Material:

.1 Fire protective impact safety rated laminated glass ceramic with hose stream, fire rating as indicated.

.2 Conforming to CAN/ULC S104 and CAN/ULC S106

.2 Product and Manufacturer:

.1 PYRAN Platinum L as manufactured by SCHOTT Technical Glass Solutions

.2 Keralite Select L as manufactured by VETROTECH SAINT-GOBAIN NORTH AMERICA INC

.3 Firelite Plus Premium as manufactured by Nippon Glass.

.3 Design Requirements:

.1 Thickness: 8 mm thick.

.2 Weight: 19.5 kg/m²

.3 Sound Transmission Rating: 36 STC.

.4 Appearance: Neutral colouration free of amber tints.

.5 Fire Rating: Fire rated from 20-180 minutes with hose stream.

.6 Impact Safety Rating: Meet CPSC 16 CFR 1201 Category I & II.

.7 Cradle to Cradle Certification: Must be C2C Silver Certified.

.8 Polished finish.

.9 ANZI Z97 Impact Safety Filmed and Laminated

.10 Environmental Impact: Manufacturing process and final composition free from toxins or hazardous heavy metals.

.4 Each piece of fire-rated glazing material shall be labeled with a permanent logo including name of product, manufacturer, testing laboratory and fire rating.

2.2 Accessories

.1 Glazing Accessories: Manufacturer recommended fire rated glazing accessories as follows:

.1 Glazing tape: Closed cell polyvinyl chloride (PVC) foam, Pemko Manufacturing Company, FG3000S90 or Unifax Corporation Fiberfrax Alumino-Silicate fiber glazing tape.

.2 Setting blocks: Calcium silicate or hardwood.

.3 Cleaners, primers, sealers: Type recommended by manufacturer of glass and gaskets.

2.3 Related Products

.1 Glazing shall be installed in an equally rated framing system.

2.4 Source Quality

.1 Obtain fire rated glazing products from a single manufacturer.

.2 Fabrication Dimensions: Fabricate to required dimensions.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

.1 Comply with manufacturer's product data including product technical bulletins and installation instructions.

3.2 Examination

.1 Verify substrate conditions, have been previously installed under other sections, and are acceptable for product installation in accordance with manufacturer's instructions.

3.3 Installation

.1 Comply with referenced GANA manuals and instructions of manufacturers of glass, glazing sealants and glazing compounds.

.2 Protect glass from edge damage during handling and installation. Inspect glass during installation and set aside pieces with edge damage that could affect performance.

.3 Set units of glass in each series with uniformity of pattern, draw, bow and similar characteristics.

.4 Cut glazing tape to length and set against permanent stops, flush with sight lines to fit openings exactly, with stretch allowance during installation.

.5 Arrange two setting blocks located at quarter points of glass with edge block no more than 150 mm from corners.

- .6 Glaze vertically into labeled fire rated frames or fire rated walls with the same fire rating as the glass and push against tape for full contact at perimeter of pane or unit.
- .7 Place glazing tape on free perimeter of glazing in same manner described above.
- .8 Install removable stop and secure without displacing the tape.
- .9 Install so that appropriate markings remain permanently visible.
- .10 Field cutting or tampering is strictly prohibited.

3.4 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Protect glass from contact with contaminating substances resulting from construction operations. Remove such substances by method approved by manufacturer.
- .3 Wash glass on both faces not more than four days prior to date schedule for inspections intended to establish date of Substantial Performance. Wash glass by method recommended by glass manufacturer.
- .4 Remove temporary coverings and protection of adjacent work areas.
- .5 Remove construction debris from project site and legally dispose of debris.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

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

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM C514-04(2020) Standard Specification for Nails for the Application of Gypsum Board
 - .2 ASTM C840-20 Standard Specification for Application and Finishing of Gypsum Board
 - .3 ASTM C954-22 Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
 - .4 ASTM C1002-22 Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
 - .5 ASTM C1047-19 Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
 - .6 ASTM C1396/C1396M - 17 Standard Specification for Gypsum Board
 - .7 ASTM C1629/C1629M-19 Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels
 - .8 ASTM E90-09(2016) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
 - .9 ASTM E814-13a(2017) Standard Test Method for Fire Tests of Penetration Firestop Systems
 - .10 ASTM E1966-15(2019) Standard Test Method for Fire-Resistive Joint Systems
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34 Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
 - .2 CAN/CGSB 19-GP-21M Sealing and Bedding Compound for Acoustical Purposes
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 ULC 102-2018 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 ULC 114-2018 Standard Method of Test for Determination of Non-Combustibility in Building Materials
 - .3 ULC 129- 2015 Standard Method of Test for Smoulder Resistance of Insulation (Basket Method)
 - .4 ULC List of Equipment and Material, Volume III, Fire Resistance Ratings.
- .4 Gypsum Association (GA)
 - .1 GA-214-2022 Recommended Levels of Gypsum Board Finish.
 - .2 GA-216-2021 Application and Finishing of Gypsum Board.
- .5 Wall and Ceiling Bureau
 - .1 Technical Bulletin Control Joint Placement in Gypsum Board Assemblies

1.4 Submittals

.1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.

.2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.

1.5 Quality Assurance

.1 Dry wall installers: minimum 5 years proven experience.

.2 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

.3 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.4 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

.5 Mock-Ups

- .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
- .2 Construct mock-up gypsum board wall installation including one inside corner and one outside corner. Mock-up may be part of finished work.
- .3 Allow two working days for inspection of mock-up by Consultant before proceeding with rest of the work.
- .4 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of finished work.

1.6 Design Requirements

.1 Where indicated provide minimum sound transmission rating of installed partitions of STC 50 tested to ASTM E90.

.2 Provide fire resistance rating of installed partitions as indicated and according to referenced ULC design.

1.7 Shipping, Handling and Storage

.1 Refer to Section 01 61 00 – Common Product Requirements.

.2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

.3 Protect gypsum board materials before, during and after installation and to protect the installed work and materials of other trades affected by this work. Store materials in a dry area inside the building. Do not remove wrapping until ready for use. Prevent damage to all edges and surfaces.

1.8 Project Conditions

.1 Maintain temperature minimum 10 ° C, maximum 21 ° C for 48 hours prior to and during application of gypsum boards and joint treatment, and for at least 48 hours after completion of joint treatment.

.2 Apply board and joint treatment to dry, frost free surfaces.

- .3 Ventilation: Ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

1.9 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Gypsum Board

- .1 To ASTM C1396 Heavy Duty Abuse Resistant for non-rated applications, Type X for rated applications, 1220 mm wide x maximum practical length, ends square cut, edges tapered with round edge. Thickness as indicated on drawings.
- .2 Water and Moisture Resistant Board: to ASTM C1396, thickness as indicated, 1220 mm wide with tapered edges.

2.2 Fastening and Adhesives

- .1 Drywall Screws: To ASTM C954 or ASTM C1002 self-drilling, self-tapping, case hardened, length to suit board thickness and provide minimum 12 mm penetration into support.
- .2 Joint Tape: To ASTM C475, 50 mm perforated with preformed seam, mould and mildew resistant.
 - .1 Joint tape for abuse resistant gypsum board: CGC Mould Resistant Fiberglass Drywall Tape.
- .3 Joint Filler and Topping: To ASTM C475 vinyl or latex base, slow setting.

2.3 Acoustic Insulation

- .1 Acoustic Attenuation: Min 50 STC in accordance with ASTM E90.
- .2 Acoustic Insulation: Mineral or Glass Fibre Acoustic Insulation:
 - .1 Mineral Fibre Acoustic Insulation: To ASTM C665, Mineral fibre blanket insulation, minimum density of 40 kg/m³:
 - .1 AFB Acoustical Fire Batts manufactured by Roxul Inc.
 - .2 Creased SAFB manufactured by Owens Corning Canada.
 - .2 Glass Fibre Acoustic Blanket Insulation: To CAN/ULC-S702, type 1, pre-formed unfaced glass fibre batt acoustic insulation.
 - .1 QUIETZONE Acoustic Blanket insulation manufactured by Owens Corning Canada.
- .3 Surface burning characteristics to ULC 102:
 - .1 Flame spread: 15
 - .2 Smoke developed: 5
 - .3 Smoulder resistance: to ULC 129.
 - .4 Non-combustible: to ULC 114
- .4 Thickness to suit depth of wall framing and as indicated.
- .5 Acoustic sealant: as specified in Section 07 92 00 - Joint Sealants.

2.4 Accessories

- .1 Casing beads, corner beads, control joints and edge trim: to ASTM C1047, zinc-coated by hot-dip process 0.5 mm base thickness, perforated flanges, one piece length per location.
- .2 Insulating Strip: Rubberized, moisture resistant, 3.0 mm thick, 12 mm wide closed cell neoprene strip, with self-sticking permanent adhesive on one face; lengths as required.
- .3 Sealants: as specified in Section 07 92 00 - Joint Sealants.

PART 3 EXECUTION

3.1 General

- .1 Prior to installation of gypsum wallboard, ensure that all required vapour barriers, air seals, gaskets and the like installed under another Section have been inspected and accepted by Municipal authorities and the Consultant. Failure to do so will result in removal of all gypsum board installed prior to approval and replacement, at no additional cost to the Owner.
- .2 Unless otherwise indicated on the drawings, all gypsum board partitions shall extend from floor level to the underside of floor or roof structures above.

3.2 Acoustic Insulation

- .1 Install acoustic blankets full width and length, with tight joints, between wall framing and around penetrating electrical service boxes, piping, air ducts and frames.
- .2 Place acoustic blankets where indicated on the Drawings and to thickness required to obtain acoustic performance indicated for the assembly.
- .3 Place acoustic blankets between studs ensuring friction fit, free of sags, folds or open joints that may let sound pass through.
- .4 Install blankets from the bottom up, tightly adjusted and trim accurately with a utility knife.

3.3 Gypsum Board Application

- .1 Do not apply drywall to reinforced partitions until plywood backing specified in section 06 10 00 is installed and accepted by the Consultant.
- .2 Do application and finishing of gypsum board in accordance with ASTM C840 and/or GA-216 except where specified otherwise.
- .3 Do not apply gypsum board until bucks, anchors, blocking, electrical, and mechanical work are approved.
- .4 Apply gypsum board at right angles to framing members or furring using screw fasteners. Maximum spacing of screws 300 mm o.c.
- .5 Install fibre gypsum abuse resistant panels at all ceilings and bulkheads except as noted below. Treat joints with fibreglass reinforced joint tape in accordance with manufacturer's instructions.
- .6 Apply moisture resistant gypsum wallboard where indicated. Apply water resistant sealant to edges, ends and cut outs which expose gypsum core.

- .7 Carry gypsum board from floor to underside of floor or roof structure above. Furr out and carry gypsum board around any structural members as may be required. Neatly cope gypsum board to fill deck flutes where gypsum board abuts floor or roof deck.

3.4 Accessories

- .1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges.
- .2 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated.
- .3 Install insulating strips continuously at edges of gypsum board or casing beads abutting exterior door or window frames, to provide thermal break.
- .4 Install continuous bead of acoustic sealant at all penetrations through sound control partitions.
- .5 Provide control joints in gypsum board facing. Construct control joints in accordance with ASTM C840 and as described in Wall and Ceiling Bureau Technical Bulletin "Control Joint Placement in Gypsum Board Assemblies". Place control joints consistent with lines of building spaces as indicated. Where not indicated install as directed at maximum 6.0 m spacing. Control joints shall be supported with metal studs or furring channels on both sides of the joint. Construct joints using back-to-back casing beads filled with a low modulus sealant capable of flexible joint movement. Maintain fire-resistance rating of wall assemblies. Control joints shall be provided:
 - .1 At abutting structural elements, steel columns.
 - .2 At expansion or control joints in the substrate.
 - .3 At each door jamb.

3.5 Access Doors

- .1 Install access doors to electrical and mechanical fixtures specified in respective Sections.
- .2 Rigidly secure frames to furring or framing systems, to satisfy fire rating requirements.

3.6 Taping and Filling

- .1 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces. Finish to GA-214 Level 5.
- .2 Finish corner beads, control joints and trims as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.
- .3 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after painting is completed.
- .4 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
- .5 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for painting.

3.7 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 09 21 16 Gypsum Board

1.3 References

- .1 ASTM International (ASTM).
 - .1 ASTM A653/A653M-23 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - .2 ASTM C645-18 Standard Specification for Nonstructural Steel Framing Members
 - .3 ASTM C754-20 Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
 - .4 ASTM C841-03(2018) Standard Specification for Installation of Interior Lathing and Furring.
 - .5 ASTM C1002-22 Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
 - .6 ASTM E90-09(2016) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
 - .7 ASTM E814-13a(2017) Standard Test Method for Fire Tests of Penetration Firestop Systems
 - .8 ASTM E1966-15(2019) Standard Test Method for Fire-Resistive Joint Systems
- .2 Canadian General Services Board (CGSB).
 - .1 CAN/CGSB-1.40-97 Primer, Structural Steel, Oil Alkyd Type.
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 ULC List of Equipment and Material, Volume III, Fire Resistance Ratings.
- .4 CSSBI Lightweight Steel Framing Manual

1.4 Submittals

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

1.5 Quality Assurance

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

1.6 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.

- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

1.7 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Metal Stud Framing Systems

- .1 Non-load bearing channel stud framing: to ASTM C645, stud size as indicated, roll formed from 0.53 mm thickness hot dipped galvanized steel sheet, for screw attachment of gypsum board. Knock-out service holes at 460 mm centres.
 - .1 Thickness of materials to conform to referenced standards unless noted otherwise.
 - .2 Thickness of materials shall be selected from manufacturer's standard span tables to suit total height requirements.
- .2 Floor and ceiling tracks: to ASTM C645, in widths to suit stud sizes, 32 mm flange height.
- .3 Metal channel stiffener: 1.4 mm thick cold rolled steel, coated with rust inhibitive coating.
- .4 Tie Wire: 0.90 mm, galvanized, soft annealed, steel wire or clip as recommended by the manufacturer of furring channels.
- .5 Wind bearing light weight steel stud framing for exterior wall applications is specified in Section 05 41 00.

2.2 Metal Furring and Suspension Systems

- .1 Channel framing: to ASTM C645, stud size as indicated, roll formed from 0.53 mm thickness hot dipped galvanized steel sheet, for screw attachment of gypsum board.
 - .1 Thickness of materials to conform to referenced standards unless noted otherwise.
- .1 Metal Furring Runners, Hangers, Tie Wires, Inserts, Anchors: to ASTM C645 , electro-zinc coated steel.
- .2 Runner Channels: 38 x 19 x 0.59 mm and 38 x 9.5 x 0.45 mm, hot dip or electro-galvanized sheet steel. Use of various sizes governed by applied loads and applicable spans.
- .3 Drywall Furring Channel: Channel shaped furring member for screw attachment of drywall with knurled face. For interior use. Furring masonry or concrete surfaces. Cross furring under steel joist or suspended metal channels in suspended ceiling systems: 70 x 22 x 0.9 mm with knurled face, hot dip or electro-galvanized sheet steel. Bailey D-1001.
- .4 Deflection Track: Bailey Multi-Slot Track MST 250, size to suit studs, and top deflection clips TDC 350 and TDC 587.
- .5 Horizontal Flange attachment: Bailey Horizontal Flange Attachment Clip (HFA Clip)
- .6 Hangers: minimum 4.1 mm diameter (or as required by ULC fire rating design requirements) mild steel rods.

2.2 Fasteners

- .1 Powder activated fasteners: to suit structural conditions and fastening requirements and in accordance with manufacturer's recommendations: Ramset; Hilti; or approved equivalent.
- .2 Sheet Metal Screws: To ASTM C1002, self-drilling, self-tapping, case hardened, length to suit board thickness and provide minimum 12 mm penetration into support.

2.3 Accessories

- .1 Acoustic sealant: As specified in Section 07 92 00.
- .2 Insulating strip: rubberized, moisture resistant 3 mm thick foam strip, 12 mm wide, with self-sticking adhesive on one face, lengths as required.
- .3 Zinc Rich Paint: to CGSB 1-GP-181M. Low VOC type.

PART 3 EXECUTION

3.1 Examination

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

3.2 Erection

- .1 Comply with ASTM C754.
- .2 All gypsum board shall be supported with steel framing whether indicated or not.
- .3 Unless otherwise indicated on the drawings, all gypsum board partitions shall extend from floor level to the underside of floor or roof structures above.
- .4 Align partition tracks at floor and ceiling and secure at 600 mm on centre maximum. Provide top deflection tracks where indicated or as required to permit structural deflection. Install top deflection clips as necessary to increase load capacity.
- .5 Install damp proof course under stud shoe tracks of partitions on slabs on grade.
- .6 Place studs vertically at 400 mm on centre unless noted otherwise and not more than 50 mm from abutting walls, and at each side of openings and corners. Position studs in tracks at floor and ceiling. Cross brace steel studs as required to provide rigid installation to manufacturer's instructions.
- .7 Erect metal studding to tolerance of 1:1000.
- .8 Attach studs to bottom and ceiling track using screws.
- .9 Co-ordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.

- .10 Co-ordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other Sections.
- .11 Provide two studs extending from floor to ceiling at each side of openings wider than stud centres specified. Secure studs together, 50 mm apart using column clips or other approved means of fastening placed alongside frame anchor clips.
- .12 Install heavy thickness single jamb studs at openings.
- .13 Erect track at head of door/window openings and sills of window openings to accommodate intermediate studs. Secure track to studs at each end, in accordance with manufacturer's instructions. Install intermediate studs above and below openings in same manner and spacing as wall studs.
- .14 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals. Check clearances with equipment suppliers.
- .15 Provide 40 mm stud or furring channel secured between studs for attachment of fixtures behind lavatory basins, toilet and bathroom accessories, and other fixtures including grab bars and towel rails, attached to steel stud partitions.
- .16 Install steel studs or furring channel between studs for attaching electrical and other boxes.
- .17 Maintain clearance under beams and structural slabs to avoid transmission of structural loads to studs. Use 50 mm leg ceiling tracks.
- .18 Erect drywall resilient furring transversely across studs and joists, spaced maximum 600 mm on centre and not more than 150 mm from ceiling/wall juncture. Secure to each support with 25 mm drywall screws.
- .19 Install 150 mm continuous strip of 12.7 mm gypsum board along base of partitions where resilient furring installed
- .20 Install continuous insulating strips to isolate studs from un-insulated surfaces.
- .21 Install two continuous beads of acoustical sealant under studs and tracks around perimeter of sound control partitions.

3.3 Wall Furring

- .1 Install wall furring for gypsum board wall finishes in accordance ASTM C754 and ASTM C841 except where specified otherwise and indicated on drawings.
- .2 Frame openings and around built-in equipment, cabinets, access panels, etc., on four sides. Extend furring into reveals. Check clearances with equipment suppliers.
- .3 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

3.4 Suspended and Furred Ceilings and Bulkheads

- .1 Erect hanger and runner channels for suspended gypsum board ceilings and bulkheads in accordance with ASTM C754 and ASTM C841 except where specified otherwise and indicated on drawings.

- .2 Securely anchor hanger to structural supports 1220 mm o.c. maximum along runner channels and not more than 150 mm from ends. Under no circumstances shall hanger wires be secured to or supported from mechanical or electrical materials or equipment or penetrate mechanical ductwork.
- .3 Space runner or furring channels as shown on drawings and not more than 610 mm o.c. maximum nor 150 mm from walls. Run channels in long direction of board. Bend hanger sharply under bottom flange of runner and securely wire in place with a saddle tie. Provide channels below mechanical or electrical equipment and mechanical ductwork to maintain maximum spacing.
- .4 Install furring channels transversely across runner channels in short direction of wallboard at 610 mm o.c. maximum or 150 mm from walls and interruptions in ceiling continuity. Secure channels to support with furring clips or wire. Where splicing is necessary lap minimum 200 mm and wire tie each end with double loops of 0.90 mm galvanized tie wire, 25 mm from each end of overlap.
- .5 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 610 mm around perimeter of fixture. Coordinate with Electrical.
- .6 Install work level to tolerance of 1:1200.
- .7 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, grilles, etc.
- .8 Install furring channels parallel to, and at exact locations of steel stud partition header track.
- .9 Furr for gypsum board faced vertical bulkheads within or at termination of ceilings.

3.5 Gypsum Board

- .1 Installation of gypsum board is specified in Section 09 21 16

3.6 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 07 92 00 Joint Sealants

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM C144-18 Standard Specification for Aggregate for Masonry Mortar
 - .2 ASTM C150/C150M-22 Standard Specification for Portland Cement
- .2 American National Standards Institute (ANSI)
 - .1 ANSI A108/A118/A136.1:2017 American National Specifications for the Installation of Ceramic Tile.
 - .2 ANSI A137.1: 2017 American National Standard Specifications for Ceramic Tile
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 71-GP 22M 1978 Adhesive, Organic, for Installation of Ceramic Wall Tile
- .4 International Standards Organization (ISO)
 - .1 ISO 10545 Series Ceramic Tiles, Standards for Testing
 - .2 ISO 13006-2012 Ceramic Tiles, Definitions, Classifications, Characteristics and Marking.
 - .3 ISO 13007-2010 Ceramic Tiles, Grouts and Adhesives.
- .5 Terrazzo, Tile and Marble Association of Canada (TTMAC)
 - .1 TTMAC 2019-2021 Specifications Guide 09 30 00, Tile Installation Manual.

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Provide product data. Include manufacturer's information on:
 - .1 Ceramic tile, marked to show each type, size, and shape required.
 - .2 Mortar and grout.
 - .3 Divider strip.
 - .4 Levelling compound.
 - .5 Waterproofing isolation membrane.
- .3 Submit duplicate samples of tile. Samples to be submitted on 300 x 600 mm sample board for each colour, texture, size and pattern of tile. Grout sample joints for representative sample of final installation.
- .4 Trim and Accessories: submit duplicate samples of each trim.
- .5 Maintenance Data: Provide maintenance data for tile work, for incorporation into Maintenance Manuals specified under Section 01 78 00.

1.5 Quality Assurance

- .1 Do tile work in accordance with Installation Manual 200, Ceramic Tile, by Terrazzo, Tile and Marble Association of Canada (TTMAC), except where this specification is more stringent.

- .2 For the installation of ceramic tile, use only skilled tradesmen who are familiar with the referenced standards and with the requirements for this Work.
- .3 The setting material manufacturer's representative shall review the details with the Contractor prior to the start of work. Instruct the Contractor on the proper installation procedures to ensure compliance with the guarantee requirements.

1.6 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver packaged materials in original unopened containers.
- .3 Keep delivered material dry and free from stains. Store cementitious material off damp surfaces.
- .4 Use all means necessary to protect materials, before, during and after installation and to protect the installed work and materials of all other trades.
- .5 In the event of damage, immediately make all repairs and replacements necessary to the approval of the Consultant and at no additional cost to the Owner.
- .6 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

1.7 Project Conditions

- .1 Maintain air temperature and structural base temperature at ceramic tile installation area above 12 °C for 48 hours before, during and after installation.
- .2 Do not install tiles at temperatures less than 12 °C or above 38 °C.
- .3 Do not apply epoxy mortar and grouts at temperatures below 15 °C or above 25 °C.
- .4 Provide and maintain temporary lighting. Lighting levels shall be sufficient to complete work including inspections. Provide minimum lighting levels of 400 lux at work areas.

1.8 Qualifications

- .1 Installer of ceramic tiles shall have a minimum of 10 years of experience including at least five projects of similar scope and scale. Submit documented proof of experience prior to commencing work of this Section.

1.9 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

1.10 Maintenance

- .1 Upon completion of the installation and as a condition of acceptance, deliver to the Owner 2% of tile and accessory tiles in each colour and pattern of ceramic tiles installed under this section for the Owners maintenance program. Identify each carton for location and installation date. Submission must be made all at one time and prior to Substantial Performance.

1.11 Warranty

- .1 Warrant the work of this Section against defects of workmanship and material, for a period of five years from the date of Substantial Performance and agree to make good promptly any defects which occur or become apparent within the warranty period.

PART 2 PRODUCTS

2.1 Materials

- .1 Materials shall be graded and containers grade sealed, delivered to the job site in their original packages or containers with the manufacturer's labels and seals intact.
- .2 Tile and grout colours shall be selected by the Consultant from the manufacturer's standard range of colours.
- .3 Tile shall conform to ANSI A137.1.
- .4 Provide coves, corners, reveals, surf caps, inners and outers as required to complete the work.

2.2 Ceramic Tile

- .1 CT: Ceramic Wall Tile: Daltile (American Olean) Color Story Wall 4" x 16" Glossy. Up to 10 colours to be
 - .1 CT1: Ice White 0025
 - .2 CT2: Calm 0035
 - .3 CT3: Balance 0014
 - .4 CT4: Storm 0040
- .2 Wall base for Terrazzo gypsum wall areas: Provide surface bullnose top cove S44D9/4" x 16" where indicated.
- .3 Alternate pricing PCT1 Corridor Tile: Centura Basaltina 12"x24" Matte Light Grey
 - .1 Provide Satin Anodized Finish wall corner edge flat provide protection for Centura Basaltina 12"x4" Wall base

2.3 Mortar, Adhesives and Grout Material

- .1 Primer: Low VOC, low viscosity primer as recommended by manufacturer to suit substrate and site conditions; provide proof of bonding ability of setting systems where manufacturer recommends that a primer is not necessary to installation.
- .2 Surface Preparation Materials:
 - .1 Portland Cement Mortar: Scratch and bond coat, levelling bed containing the following:
 - .1 Portland Cement: Meeting or exceeding requirements of CSA A3000, Type GU.
 - .2 Hydrated Lime: Meeting or exceeding requirements of ASTM C207, Type N.
 - .3 Sand: Meeting or exceeding requirements of ASTM C144, passing 16 mesh.
 - .4 Water: Potable.
 - .2 Self Levelling and Smoothing Underlayment: Cementitious and self levelling smoothing underlayment meeting or exceeding requirements of ANSI A108.1, Type 2.
- .3 Wall Tile Systems:
 - .1 Thin Set Interior Installation: Dry set mortar meeting or exceeding requirements of ANSI A118.1 formulated for thin set applications, factory sanded mortar consisting of Portland

cement, sand and additives requiring only addition of potable water for installation complete with bond enhancing latex additive.

.4 Adhesive Systems:

- .1 Epoxy Adhesive: Thin set adhesive system using 100% solids epoxy resin and epoxy hardener meeting or exceeding requirements of ANSI A108.1; stain proof, chemical resistant and having high temperature resistance and water cleanable.

.5 Tile Grout Systems:

- .1 Stain and mould resistant grout meeting or exceeding requirements of ANSI A118.7. TEC Power Grout or Profix Alpha High Performance Grout.

2.4 Accessories

- .1 Reducers, edge trim, and transition strips: Schluter Systems purpose made aluminum.
- .2 CT Edge Protection: Schluter RONDEC, size to suit tile thickness. Satin anodized aluminum. Trim to come with all connectors or end caps required for a complete and finished installation. As a minimum, provide edge protection at the following locations:
- .1 All outside corners of wall tile or porcelain ceramic tile base.
- .3 Sealant: as specified in Section 07 92 00.

2.5 Mixes

- .1 Mix premanufactured mortars and grouts in accordance with referenced standards, and mortar and grout manufacturer's written instructions; mix site mixed materials as follows:
- .1 Scratch Coat (by volume): Mix 1 part Portland cement, 4 parts sand, and latex additive where required by TTMAC detail.

PART 3 EXECUTION

3.1 Surface Conditions

- .1 Surfaces on which tile is to be applied, shall be thoroughly cleaned down.
- .2 Verify that concrete substrates have been allowed to cure for a minimum of 28 days in accordance with TTMAC requirements.
- .3 Verify that substrates for bonding tile are firm; dry; clean; free from oil, waxy films, and curing compounds; and are within starting flatness tolerances as specified in Section 03 30 00, and are ready for application of levelling materials specified in this Section.
- .4 Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of Work, and similar items located in or behind tile have been completed before installing tile.
- .5 Drywall surfaces on which wall tile is to be applied, shall be free from dust, excess plaster and shall be plain and true without any irregularities. Prepare existing gypsum board surfaces as recommended by TTMAC and product manufacturer to support tile installation.
- .6 Existing painted masonry or concrete wall surfaces to receive ceramic tile shall be thoroughly cleaned of all paint down to concrete or concrete block surfaces using paint stripper. Prepare painted surfaces in accordance with manufacturer's instructions and TTMAC recommendations.

- .7 In the event of discrepancies, immediately notify the Consultant and do not proceed with installation in such areas until all such discrepancies have been fully resolved.
- .8 Check that conditions of temperature, humidity, traffic and usage are suitable as required by Installation Manual specifications. Minimum temperature to be not less than 10°C.
- .9 Check that surfaces ready to receive tiling are cured, level and/or graded, plumb, smooth, firm, free from loose particles, droppings, projection, grease, solvent, paint and other foreign matter and from other unsuitable conditions.
- .10 Install transition strips, reducers and edge trim at exposed edges of all tiled walls in accordance with manufacturer's instructions.

3.2 Installation

- .1 Install tiling in accordance with requirements of TTMAC Tile Installation Manual and parts of ANSI A108 Series of tile installation standards that apply to types of bonding and grouting materials, and to methods required for complete tile installation.
- .2 Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions:
 - .1 Terminate Work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
 - .2 Make cut edges smooth, even and free from chipping.
 - .3 Do not split tile.
- .3 Accurately form intersections and returns; perform cutting and drilling of tile without marring visible surfaces:
 - .1 Cut, drill, and fit tile to accommodate work of other subcontractors penetrating or abutting work of this Section.
 - .2 Carefully grind cut edges of tile abutting trim, finish, or built in items for straight aligned joints.
 - .3 Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so that plates, collars, or covers overlap tile and to provide a uniform joint appearance.
- .4 Lay tile in pattern indicated on Drawings and as follows:
 - .1 Centre tile patterns between control and movement joints; notify Consultant for further instructions where tile patterns do not align with control or movement joints.
 - .2 Cut tile accurately and without damage.
 - .3 Smooth exposed cut edges with abrasive stone, where exposed.
 - .4 Chipped or split edges are not acceptable.
- .5 Bonding Bed: Set tile in place while bond coat is wet and tacky and as follows:
 - .1 Adjust amount of bonding materials placed on substrates based on temperature and humidity to prevent skinning over of bonding materials.
 - .2 Use sufficient bond coat to provide a minimum 80% contact for tiles smaller than 300 mm x 300 mm with bonding material evenly dispersed and pressed into back of tile; refer to back buttering requirements for larger materials and installations having Moderate or higher Load Bearing Performance requirements.
 - .3 Notch bond coat in horizontal straight lines and set on freshly placed bonding material while moving (sliding) tile back and forth at 90° to notches.
 - .4 Verify that corner and edges are fully supported by bonding material.
 - .5 Set tiles to prevent lippage greater than 1 mm over a 3 mm grout joint.
 - .6 Keep two-thirds of grout joint depth free of bonding materials.

- .7 Clean excess bonding materials from tile surface prior to final set.
- .8 Sound tiles after bonding materials have cured and replace hollow sounding tile before grouting.
- .6 Back Buttering: Obtain 100% mortar coverage in accordance with applicable requirements for back buttering of tile in referenced TTMAC and ANSI A108 series of tile installation standards
- .7 Control and Movement Joints: Install control joints and expansion joints in tile work in accordance with TTMAC Detail 301MJ; keep control and expansion joints free of bonding materials and as follows:
 - .1 Cut tiles to establish line of joints; sawn joints after installation of tiles will not be acceptable.
 - .2 Install prefabricated joint profiles in accordance with manufacturer's written instructions, set with top surface of joint profile slightly below top surface of tile.
 - .3 Prepare joints and apply sealants in accordance with requirements of Section 07 92 00.
 - .4 Keep control and movement joints free from setting materials.
 - .5 Form an open joint for sealant in tile wherever a change in backing material occurs, at all vertical interior corners, around penetrating pipes and fixtures, and where tile abuts other materials or fixtures.

3.3 Grouting

- .1 Grouting: Install grout in accordance with manufacturer's written instructions, the requirements of TTMAC, and as follows:
 - .1 Allow proper setting time before application of grout.
 - .2 Pre-seal or wax tiles requiring protection from grout staining.
 - .3 Force grout into joints to a smooth, dense finish.
 - .4 Remove excess grout in accordance with manufacturer's written instructions and polish tile with clean cloths.
- .2 Grout all tile using specified grout in strict accordance with manufacturers written instructions all to give a flush, hard joint.
- .3 Joints in tile shall be filled solid and flush with grout.
- .4 Prepare joints and mix grout in accordance with manufacturer's printed instructions. Force maximum amount of grout into joints, avoiding air traps or voids.
- .5 Remove all excess grout by washing diagonally across the joints. Check for voids, air pockets and gaps and fill same. Remove all discoloured grout and replace with new.
- .6 Cure all joints.

3.4 Cleaning and Protection

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Cleaning: Clean tile surfaces so they are free of foreign matter using manufacturer recommended cleaning products and methods after completion of placement and grouting and as follows:
 - .1 Remove grout residue from tile as soon as possible.
 - .2 Flush surface with clean water before and after cleaning.
- .3 Protection: Leave finished installation clean and free of cracked, chipped, broken, unbonded, or other tile deficiencies as follows:
 - .1 Protect finished areas from traffic until setting materials have sufficiently cured in accordance

with TTMAC requirements.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 09 21 16 Gypsum Board
- .2 Section 09 53 00 Acoustical Suspension

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM C423-23 Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
 - .2 ASTM E84-23c Standard Test Method for Surface Burning Characteristics of Building Materials
 - .3 ASTM E1264-22 Standard Classification for Acoustical Ceiling Products
 - .4 ASTM E1414/E1414M-21a Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
 - .5 ASTM E1477-98a(2022) Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 ULC 102-2018 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: Submit manufacturer's technical data for each type of acoustical ceiling unit and suspension system required.
 - .1 Acoustical Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards. For acoustical performance, each carton of material must carry an approved independent laboratory classification of NRC, CAC, and AC.
- .3 Submit duplicate 300 x 300 mm samples of each type of acoustical units.
- .4 Provide maintenance data for acoustic panel ceilings for incorporation into Operation and Maintenance Manual specified in Section 01 78 00 – Closeout Submittals.

1.5 Quality Assurance

- .1 Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.
 - .1 Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.
 - .2 Surface Burning Characteristics: As follows, tested per ASTM E84 and complying with ASTM E1264 Classification.
 - .3 Fire Resistance: As follows tested per ASTM E119 and listed in the appropriate floor or roof design in the Underwriters Laboratories Fire Resistance Directory

- .2 Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.
- .3 Mock-up:
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .2 Construct mock-up 10 m² minimum of acoustical panel tile ceiling including one inside corner and one outside corner.
 - .3 Construct mock-up where directed.
 - .4 Allow 48 hours for inspection of mock-up by Consultant before proceeding with ceiling work.
 - .5 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of the finished work.

1.6 Project Conditions

- .1 Permit wet work to dry before beginning to install.
- .2 Maintain uniform minimum temperature of 15° C and humidity of 20-40% before and during installation.
- .3 Store materials in work area 48 hours prior to installation.
- .4 Building areas to receive ceilings shall be free of construction dust and debris.

1.7 Performance Requirements

- .1 Surface-Burning Characteristics: Conform to ULC S102 or ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- .2 Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to applicable code.

1.8

Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.
- .3 Protect on site stored or installed absorptive material from moisture damage.

1.9 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

1.10 Extra Materials

- .1 Provide extra materials of acoustic units in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide acoustical units amounting to 5% of gross ceiling area for each pattern and type required for project.
- .3 Ensure extra materials are from same production run as installed materials.

PART 2 PRODUCTS

2.1 Materials

- .1 Acoustic units for suspended ceiling system: to ASTM E1264
- .2 Panel Type 1: Armstrong Cortega Square Lay-in
 - .1 Class A.
 - .2 Composition: Wet formed Mineral Fiber
 - .3 Pattern non-directional fissured.
 - .4 Texture: medium.
 - .5 Flame spread: ASTM E1264, Class A (U.L.C.), 25 or less.
 - .6 Smoke developed 50 or less in accordance with ULC S102.
 - .7 Noise Reduction Coefficient (NRC): ASTM C423; Classified with UL label, 0.55
 - .8 Ceiling Attenuation Class (CAC): ASTM C1414; Classified with UL label, 35
 - .9 Light Reflectance (LR) range of 0.82 to ASTM E1477.
 - .10 Dimensional Stability: Standard
 - .11 Edge Profile: Square Lay-In
 - .12 Colour: White.
 - .13 Size 610 x 1219 x 16 mm thick.
 - .14 Shape flat.
- .3 Alternate manufacturer: Products as manufactured by the following are acceptable, subject to Consultants approval of style, finish, performance characteristics and texture:
 - .1 Armstrong Industries
 - .2 Certainteed
- .4 Ceiling Suspension System: as specified in Section 09 53 00.

PART 3 EXECUTION

3.1 Examination

- .1 Do not install acoustical panels until work above ceiling has been inspected by Consultant.

3.2 Installation

- .1 Co-ordinate with Section 09 53 00 - Acoustical Suspension.
- .2 Coordinate layout and installation of ceilings with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, and fire-suppression system.
- .3 Install acoustical panels and tiles in ceiling suspension system.
- .4 Install acoustical units parallel to building lines with edge unit not less than 50% of unit width, with directional pattern running in same direction. Refer to reflected ceiling plan.
- .5 Scribe acoustic units to fit adjacent work. Butt joints tight, terminate edges with moulding.

3.3 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 09 21 16 Gypsum Board
- .2 Section 09 51 13 Acoustic Panel Ceilings

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM A307-21 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
 - .2 ASTM A641/A641M-19 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - .3 ASTM A653 / A653M – 23 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - .4 ASTM A1011/A1011M-23 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 - .5 ASTM C635/C635M-22 Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay in Panel Ceilings.
 - .6 ASTM C636/C636M-19 Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
 - .7 ASTM E84-23c Standard Test Method for Surface Burning Characteristics of Building Materials
 - .8 ASTM E119-22 Standard Test Methods for Fire Tests of Building Construction and Materials
 - .9 ASTM E1264-22 Standard Classification for Acoustical Ceiling Products

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: Submit manufacturer's technical data for each type of acoustical ceiling unit and suspension system required.
- .3 Acoustical Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards.
- .4 Submit one representative model of each type of ceiling suspension system.
 - .1 Ceiling system to show basic construction and assembly, treatment at walls, recessed fixtures, splicing, interlocking, finishes, acoustical unit installation.

1.5 Design Requirements

- .1 Determine the superimposed loads that will be applied to suspension systems by components of the building other than the ceiling and ensure that adequate hangers are installed to support the additional loads in conjunction with the normal loads of the system.
- .2 Design supplemental suspension members and hangers where width of ducts and other

construction within ceiling plenum produces hanger spacing that interferes with location of hangers at required spacing to support standard suspension system members:

- .1 Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- .3 Rigidly secure acoustic ceiling system including integral mechanical and electrical components with maximum deflection of L/360 to ASTM C635 deflection test.

1.6 Performance Requirements

- .1 Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to applicable code.

1.7 Quality Assurance

- .1 Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.
- .2 Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.
 - .1 Surface Burning Characteristics: Tested per ASTM E84 and complying with ASTM E1264 Classification.
- .3 Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.
- .4 Where required, provide fire-resistance rated suspension system: certified by a Canadian Certification Organization accredited by Standards Council of Canada.
- .5 Construct mock-ups in accordance with Section 01 45 00 - Quality Control and as described in Section 09 51 13.

1.8 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

1.9 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 Components: All main beams and cross tees, base metal and end detail shall be commercial quality hot-dipped galvanized steel as per ASTM C635. Main beams and cross tees shall be double-web steel construction with type exposed flange design. Exposed surfaces chemically cleansed, capping pre-finished galvanized steel in baked polyester paint. Main beams and cross tees shall have rotary stitching.
- .2 Face width: 22 mm

- .3 Edge Moldings and Trim: Hemmed angle moulding to match main beams and cross tees.
- .4 Structural Classification: Intermediate Duty System, ASTM C635.
- .5 Colour: White and match the actual colour of the specified ceiling tile.
- .6 Standard of Acceptance:
 - .1 Armstrong Prelude XL
 - .2 Donn DXT
 - .3 Certainteed Classic Environmental Stab.
- .7 Attachment Devices: Size for five times design load indicated in ASTM C635, Table 1, Direct Hung unless otherwise indicated or required.
- .8 Threaded Rod: to ASTM A397. Galvanized or zinc plated.
- .9 Wire for Hangers and Ties: ASTM A641, Class 1 zinc coating, soft annealed, with a yield stress load of at least three times design load, but not less than 2.06 mm thick.
- .10 Channel Framing and Fittings: Strut type metal framing and components to ASTM A1011 or ASTM A653. Unistrut P1000SL or equivalent. Galvanized.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Examination

- .1 Do not proceed with installation until all wet work such as concrete, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.

3.3 Preparation

- .1 Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures.
- .2 Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.
 - .1 Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

3.4 Installation

- .1 Install suspension system and panels in compliance with ASTM C636; CISCA Seismic Guidelines and in accordance with the manufacturer's installation instructions.

- .2 Install wall moldings at intersection of suspended ceiling and vertical surfaces.
- .3 Do not erect ceiling suspension system until work above ceiling has been inspected by Consultant.
- .4 Secure hangers to overhead structure using attachment methods as indicated by manufacturer. Do not suspend ceiling systems from building services including plumbing lines, conduit, cable trays or duct work.
- .5 Hanger and bracing wires shall not attach to or bend around obstructions including but not limited to: piping, ductwork, conduit and equipment. Provide trapeze or other supplementary support members at obstructions to allow typical hanger spacing. Brace assemblies must be configured and/or located in order to avoid obstructions in addition to maintaining the required brace assembly spacing.
- .6 Install hangers spaced at maximum 1219 mm centres and within 152 mm from ends of main tees. Install hanger wires plumb and straight.
- .7 Lay out centre line of ceiling both ways, to provide balanced borders at room perimeter with border units not less than 50% of standard unit width.
- .8 Ensure suspension system is coordinated with location of related components.
- .9 Completed suspension system to support super-imposed loads, such as lighting fixtures, diffusers, grilles, and speakers.
- .10 Support at light fixtures and diffusers with additional ceiling suspension hangers within 150 mm of each corner and at maximum 610 mm around perimeter of fixture.
- .11 Interlock cross member to main runner to provide rigid assembly.
- .12 Frame at openings for light fixtures, air diffusers, speakers and at changes in ceiling heights.
- .13 Install access splines to provide ceiling access.
- .14 Finished ceiling system to be square with adjoining walls and level within 1:1000

3.5 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Touch up scratches, abrasions, voids and other defects in painted surfaces.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 03 30 00 Cast-in-Place Concrete

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM E648-19ae1 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
 - .2 ASTM E662-21ae1 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
 - .3 ASTM F710-22 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
 - .4 ASTM F970-22 Standard Test Method for Measuring Recovery Properties of Floor Coverings after Static Loading
 - .5 ASTM F1303-04(2021) Standard Specification for Sheet Vinyl Floor Covering with Backing
 - .6 ASTM F1869-23 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
 - .7 ASTM F2170-19a Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
- .2 Resilient Floor Covering Institute (RFCI)
 - .1 RFCI Standard Slab Moisture Test Method (Calcium Chloride Method)
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 ULC 102.2-2018 Method of Test for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies.
- .4 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1113 Architectural Coatings.
 - .2 SCAQMD Rule 1168 Adhesives and Sealants Applications.

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: Submit manufacturer's current printed product literature, specifications, installation instructions, and field reports.
- .3 Submit shop drawings to indicate materials, details, and accessories including but limited to the following:
 - .1 Submit a cut diagram indicating seam locations and roll direction. Use mitered seam layouts for corners when changing directions 180 degrees (e.g. when running material down corridors which bisect at a right angle), unless approved otherwise.
- .4 Samples: Submit duplicate 300 mm x 300 mm sample pieces of sheet material.
- .5 Provide maintenance data for resilient sheet flooring for incorporation into Operation and Maintenance Manual specified in Section 01 78 00 – Closeout Submittals.

1.5 Quality Assurance

- .1 Single-Source Responsibility: provide types of flooring and accessories supplied by one manufacturer, including leveling and patching compounds, and adhesives.
- .2 Installer Qualifications: Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
 - .1 Training: Installer who has attended a manufacturer's flooring installation training clinic.
- .3 Regulatory Requirements: Provide slip resistant sheet vinyl safety flooring in compliance with the following:
 - .1 Accessibility for Ontarians with Disabilities Act (AODA).
 - .2 Occupational Safety & Health Administration (OSHA).
- .4 Mock-ups: Install at project site a job mock-up using acceptable products and manufacturer approved installation methods, including concrete substrate testing.
 - .1 Maintenance: Maintain mock-up during construction for workmanship comparison; remove and legally dispose of mock-up when no longer required.
 - .2 Incorporation: Mock-up may be incorporated into final construction upon Owner's approval.
- .5 Pre-installation Meeting: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, manufacturer's warranty requirements, and installer qualifications.
- .6 Fire Performance:
 - .1 Fire Performance Characteristics: Provide resilient vinyl sheet flooring with the following fire performance characteristics as determined by testing material in accordance with ASTM test methods indicated below by a certified testing laboratory or other testing agency acceptable to authorities having jurisdiction:
 - .1 ASTM E648 Critical Radiant Flux of 0.45 watts per sq. cm. or greater, Class I
 - .2 ASTM E662 (Smoke Generation) Maximum Specific Optical Density of 450 or less

1.6 Extra Materials

- .1 Provide extra stock materials of resilient flooring, base and adhesives in accordance with Section 01 78 00 – Closeout Submittals.
- .2 Provide 3m² of each colour, pattern and type flooring material required for this project for maintenance use.
- .3 Extra materials to be from same production run as installed materials.
- .4 Clearly identify each roll of sheet flooring and each container of adhesive

1.7 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

1.8 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

1.9 Project Conditions

- .1 Temperature Requirements: If storage temperature is below 18° C or the floor temperature is below 18° C, the sheet flooring product must be moved to a warmer place and allowed to reach this temperature before unrolling or installation.
- .2 Maintain air temperature and structural base temperature at flooring installation area between 20° C and 26° C for 48 hours before, during and 48 hours after installation.

1.10 Warranty

- .1 Warrant the work of this Section against defects of workmanship and material, for a period of five (5) years from the date of Substantial Performance and agree to make good promptly any defects which occur or become apparent within the warranty period.

PART 2 PRODUCTS

2.1 Materials

- .1 Homogeneous sheet vinyl without backing: to ASTM F1913.
 - .1 Product basis of design: Polyflor Prestige PUR Homogeneous Sheet Flooring.
 - .2 Colour: selected by Consultant. Up to three (3) colours will be selected.
- .2 Vinyl Weld Rod
 - .1 Provide solid colour vinyl weld rod as produced by flooring manufacturer, and intended for heat welding of seams. Colour shall be compatible with field colour of flooring or as selected by Consultant to contrast with field colour of flooring.
- .3 Sheet vinyl flooring by the following alternate acceptable manufacturers will be accepted subject to approval by the Consultant of material specifications and colour availability:
 - .1 Gerflor
 - .2 Johnsonite
 - .3 Tarkett
- .4 Test data:
 - .1 Flexibility (ASTM F137): Passes
 - .2 Chemical Resistance (ASTM F925): Passes
 - .3 Static Load Limit (ASTM F970): Passes 250 psi
 - .4 Resistance to Heat (ASTM F1514): $\Delta E \leq 8$
 - .5 Resistance to Light (ASTM F1515): $\Delta E \leq 8$
 - .6 Residual Indentation (ASTM F1914): Passes
 - .7 Static Coefficient of Friction (ASTM D 2047): ≥ 0.5 SCOF
 - .8 Flammability (ASTM E648, Critical Radiant Flux): Class 1 (≥ 0.45 W/cm²)
 - .9 Limited Commercial Warranty: 10 years
- .5 Base Accessories:
 - .1 Fillet Strip: 19 mm radius fillet strip compatible with resilient sheet material.
 - .2 Cap Strip: Extruded flanged zero edge vinyl reducer strip approximately 25 mm exposed height with 13 mm flange.

2.1 Adhesives

- .1 Primers and adhesives: type recommended by resilient flooring manufacturer for specific material on applicable substrate.
- .2 Provide seam adhesive at seams as recommended by the resilient flooring manufacturer.

2.2 Accessories

- .1 Subfloor Filler and Leveler: Use only gray Portland cement-based "moisture tolerant" underlayment's, and patching compounds as recommended by manufacturer. Use for filling cracks, holes or leveling. Gypsum based materials are not acceptable.
- .2 Sealing
 - .1 For sealing joints between the top of wall base or integral cove cap and irregular wall surfaces such as masonry, provide plastic filler applied according to the manufacturer's recommendations.
- .3 Transition: Provide transition/reducing strips tapered to meet abutting materials.
- .4 Threshold: Provide threshold of thickness and width to suit application.
- .5 Resilient Edge Strips: Provide resilient edge strips of width shown on the drawings, of equal gauge to the flooring, homogeneous vinyl or rubber composition, tapered or bullnose edge, with colour to match or contrast with the flooring, or as selected by the Consultant from manufacturer's standard colours.
- .6 Metal edge strips: Aluminum extruded, smooth, mill finish with lip to extend under floor finish, shoulder flush with top of adjacent floor finish.
- .7 Sealer and wax: type recommended by resilient flooring material manufacturer for material type and location. Maximum VOC limit 100 g/L to SCAQMD Rule 1113

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Examination

- .1 Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog, installation instructions.
- .2 Site Verification of Conditions: Verify substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.
- .3 Ensure concrete floors are clean and dry by using test methods recommended by flooring manufacturer.

3.3 Preparation

- .1 Flooring shall be installed over subfloors conforming to ASTM F710 for concrete and other monolithic floors or ASTM F1482 for wood subfloors.
- .2 Clean floor and apply filler; trowel and float to leave smooth, flat hard surface. Prohibit traffic until filler cured and dry.
- .3 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- .4 Conduct moisture tests per ASTM F2170 on all concrete slabs regardless of age or grade level. ASTM F-2170 Internal Relative Humidity (IRH) test results must not exceed 85%.
- .5 Do not proceed with work until results of moisture condition tests are acceptable.
- .6 When patching, a moisture tolerant patching compound must always be used.
- .7 Prime or seal concrete slab to resilient flooring manufacturer's printed instructions.

3.4 Application: Flooring

- .1 Provide high ventilation rate, with maximum outside air, during installation, and for 72 hours after installation. If possible, vent directly to outside. Do not let contaminated air recirculate through building air distribution system. Maintain extra ventilation for at least one month following building occupation.
- .2 Apply adhesive uniformly using recommended trowel. Do not spread more adhesive than can be covered by flooring before initial set takes place.
- .3 Lay flooring with seams parallel to building lines to produce a minimum number of seams. Border widths minimum 1/3 width of full material.
- .4 Run sheets in direction of traffic. Double cut sheet joints heat weld according to manufacturer's printed instructions.
- .5 As installation progresses, and after installation roll flooring with 45 kg minimum roller to ensure full adhesion.
- .6 Cut flooring around fixed objects.
- .7 Terminate flooring at centerline of door in openings where adjacent floor finish or colour is dissimilar.
- .8 Install metal edge strips at unprotected or exposed edges where flooring terminates.

3.5 Application: Integral Cove Base

- .1 Set preformed fillet strip to receive base.
- .2 Install the base with adhesive, terminate expose edge with the cap strip.
- .3 Form internal and external corners to the geometric shape generated by the cove at either straight or radius corners.

- .4 Weld joints as specified for the flooring. Seal cap strip to wall with an adhesive type sealant.
- .5 Unless otherwise specified or shown where sheet flooring is scheduled, provide integral base at intersection of floor and vertical surfaces.

3.6 Field Quality Control

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

3.7 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Remove temporary coverings and protection of adjacent work areas.
- .3 Remove excess adhesive from floor, base and wall surfaces without damage.
 - .1 Repair or replace damaged installed products.
- .4 Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance.
- .5 Sweep or vacuum all construction debris and dust, then clean the flooring with manufacturer's recommended products using an auto scrubber.

3.8 Protection

- .1 Protect new floors from time of final set of adhesive until final inspection.
- .2 Protect finished installation from damage from other trades using a non-staining, temporary floor protection system, such as a reusable textured plastic sheeting without taping to the surface of the flooring.
- .3 Prohibit traffic on floor for 48 hours after installation.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 07 92 00 Joint Sealants

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM C131/C131M-20 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - .2 ASTM D412-16(2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers -Tension
 - .3 ASTM D635-22 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
 - .4 ASTM D638-22 Standard Test Method for Tensile Properties of Plastics
 - .5 ASTM D2240-15(2021) Standard Test Method for Rubber Property—Durometer Hardness
 - .6 ASTM D2370-16(2021) Standard Test Method for Tensile Properties of Organic Coatings
 - .7 ASTM F2170 -19a Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
- .2 Canadian General Services Board (CGSB)
 - .1 CAN/CGSB-25.20 Surface Sealer for Floors.
- .3 Terrazzo Tile and Marble Association of Canada (TTMAC)
 - .1 TTMAC Specification Guide 09 30 00

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit duplicate samples of manufacturer's full range of colours for specified products for selection of colours by the Consultant.
- .3 Submit minimum 2 - 300 x 300 mm square samples of epoxy flooring in colours and finish matching existing, for review and acceptance by the Owner.
- .4 Samples for Verification: Match Consultant's samples for each type, material, colour, and pattern of terrazzo and accessory required showing the full range of colour, texture, and pattern variations expected. Label each sample to identify manufacturer's matrix colour and aggregate types, sizes, and proportions. Prepare samples of same thickness and from same material to be used for the Work.
- .5 Shop Drawings: Include terrazzo fabrication and installation requirements. Include plans, elevations, sections, component details, and attachments to other Work. Show layout of the following:
 - .1 Divider and control and expansion joint strips.
 - .2 Base and border strips.

- .6 Manufacturer's product data for each type of terrazzo and accessory. System will be evaluated on the basis of these standards. For tests not listed in published data, manufacturer shall supply missing data according to referenced standard.
 - .1 Physical properties.
 - .2 Performance properties.
 - .3 Specified tests.
 - .4 Material Safety Data Sheet.
 - .5 Manufacturer's standard warranty.
- .7 Manufacturer Experience: Furnish list of at least five epoxy terrazzo projects using material being submitted for this project installed during the past five years of the same scope, complexity and at least 50% of the square footage.
- .8 Provide maintenance data for epoxy terrazzo for incorporation into Operation and Maintenance Manual specified in Section 01 78 00 – Closeout Submittals.

1.5 Project Conditions

- .1 Evaluate slab condition prior to surface preparation, including slab moisture content and extent of repairs required, if any.
- .2 Test concrete substrates according to ASTM F2170. Do not install terrazzo or terrazzo accessories until test results are 80% or less RH. If 80% RH is not met, consult terrazzo manufacturer for additional drying or negative side moisture mitigation methods.
- .3 Prior to and during each day of installation, the terrazzo contractor shall verify that the dew point is at least -15 ° C less than the slab and air temperature.
- .4 Protect surrounding substrates and surfaces, as well as in-place equipment from damage during surface preparation and system application.
- .5 Job area shall be free of other trades during surface preparation, crack detailing, divider strip installation, terrazzo pouring, and for a period of 36 hours upon completion. Provide coordination between terrazzo contractor and general contractor or construction manager as to types of traffic allowed on poured terrazzo after pouring but before coarse grinding, or after grouting but before polishing. Once polished, job area shall be free of other trades until 36 hours after completion of seal coat.
- .6 Ensure that drains in installation area are working and raised or lowered to actual finish elevation of terrazzo.
- .7 Provide ventilation by use of fans or other devices.
- .8 Maintain lighting at minimum uniform level of 540 Lux – 650 Lux in areas where terrazzo system is being installed. If possible, schedule terrazzo installation so that permanent lights will be in place and working during installation.
- .9 Ensure that leaks from pipes and other sources are corrected prior to flooring installation.
- .10 Provide minimum substrate and atmospheric temperature of 12 ° C during stripping and pouring and until 48 hours after completion of pouring. Do not allow substrate or air temperature to fall below 4 ° C after terrazzo has been poured.

- .11 Provide protection from other trades prior to final acceptance of Owner.

1.6 Quality Assurance

- .1 Work of this Section shall be executed by a company who is a member in good standing of the Terrazzo, Tile and Marble Association of Canada. The work shall be done under proper supervision by persons skilled in the methods following the recommendations of the manufacturer of the products involved and having a minimum of two years of proven experience and who can provide proof of completion of at least five projects of similar size and complexity during last five years.
- .2 Installer Qualifications: A qualified installer who is acceptable to epoxy terrazzo manufacturer to install manufacturer's products.
- .3 Terrazzo Contractor Qualifications: Use resin manufacturer certified terrazzo contractor with at least five years of satisfactory experience in installation of resinous epoxy terrazzo with proof of T.T.M.A.C. membership.
- .4 Source Limitations: Obtain primary Epoxy Terrazzo Flooring System materials including membranes, primers, resins, and hardening agents from a single manufacturer with documented experience providing resinous ground terrazzo flooring, and proof of TTMAC membership.
- .5 Obtain aggregates, solvents and other secondary materials from source recommended by manufacturer of primary materials.
- .6 Pre installation Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00. Review methods and procedures related to terrazzo including, but not limited to, the following:
 - .1 Inspect and discuss installation procedures, joint details, jobsite conditions, substrate specification, vapor barrier details and coordination with other trades.
 - .2 Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - .3 Review special terrazzo designs and patterns.
 - .4 Review dust-control procedures.
 - .5 Review plans for concrete curing and site drying to enable timely achievement of suitable slab moisture conditions.
- .7 Comply with TTMAC Guide Specification and written recommendations for terrazzo type indicated unless more stringent requirements are specified.
- .8 Mockups: Install mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Install mockups of at least 10.0 square meters of typical flooring and base condition for each colour and pattern in locations directed by Consultant. Approved mockups may become part of the completed work if undisturbed at time of Substantial Performance.

1.7 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.
- .3 Primary system materials shall be delivered in manufacturer's undamaged, unopened containers. Each container shall be clearly marked with the following:

- .1 Product name
 - .2 Manufacturer's name
 - .3 Component designation.
 - .4 Ratio of component mixture.
 - .5 WHMIS Data Sheets.
 - .4 Handle materials by methods which prevent damage.
 - .5 Inspect direct jobsite deliveries to assure that quantities are correct and that materials comply with requirements and are not damaged.
 - .6 Replace, at no cost to Owner, material found to be defective in manufacturing or that was damaged in transit, handling or storage
 - .7 Store materials per manufacturer's instructions and as follows:
 - .1 Seals and labels shall be intact and legible.
 - .2 Temperature of storage area shall be maintained between 12 ° C and 32 °C.
 - .8 Do not use materials which have been stored for a longer period of time than the manufacturer's maximum recommended shelf life.
- 1.8 Waste Management and Disposal
- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.
- 1.9 Warranty
- .1 Warrant the work of this Section against defects of workmanship and material, for a period of two years from the date of Substantial Performance and agree to make good promptly any defects which occur or become apparent within the warranty period.

PART 2 PRODUCTS

2.1 Epoxy Terrazzo

- .1 The basis of Design is Master Terrazzo Technologies, LLC, (www.MasterTerrazzo.com).
- .2 Products of other manufacturers will be considered provided they equal or exceed the material requirements and design qualities of the specified product. Submit requests for Consultant's approval with complete technical data for evaluation.
- .3 Thickness: The system shall be installed at a thickness to match existing but not less than 9.5 mm unless otherwise indicated.

2.2 Materials

- .1 Epoxy Resin: Manufacturer's standard recommended for use indicated and in colour required for mix indicated. Low VOC type.
- .2 Physical Properties without Aggregates:
 - .1 Hardness: ASTM D2240, 70-85 Shore D.
 - .2 Minimum Tensile Strength: 33.09 mPA per ASTM D638 for a 50 mm specimen made using a "C" die per ASTM D412.

- .3 Minimum Compressive Strength: 82.7 mPA per ASTM D695, Specimen B cylinder.
- .4 Chemical Resistance: No deleterious effects by contaminants listed below after 7-day immersion at room temperature per ASTM D1308.
 - .1 Distilled water.
 - .2 Mineral water
 - .3 Isopropanol
 - .4 Ethanol
 - .5 0.025 percent detergent solution
 - .6 1% percent soap solution.
 - .7 10 percent sodium hydroxide
 - .8 10 percent hydrochloric acid
 - .9 5 percent acetic acid.
- .3 Physical Properties with Aggregates: For resin blended with Georgia White marble, ground, grouted, and cured per requirements in TTMAC Specification Guide 09 30 00. Comply with the following:
 - .1 Flammability: Self-extinguishing, maximum extent of burning 6.35 mm per ASTM D635.
 - .2 Linear Coefficient of Thermal Expansion: 11.4×10^{-7} cm/cm m per °C) for temperature range of -24° to 60° C per ASTM D696.
- .4 Bond Strength: When tested in accordance with Field Test Method for surface soundness and adhesion as described in ACI Committee No. 403 Bulletin Title No. 59-43 the Epoxy terrazzo shall comply with the following value: 100% concrete failure minimum, with 2.1 mPA minimum tensile strength.
- .5 Marble Chips:
 - .1 Sizes shall be #2's, #1's and #0's, conforming to T.T.M.A.C. gradation standards.
 - .2 Abrasion and Impact resistance when testing in accordance with ASTM C131 shall not exceed 40% loss.
 - .3 Weight gain upon 24-hour immersion in water not to exceed 0.75 %.
 - .4 Chips shall contain no deleterious or foreign matter.
 - .5 Dust content less than 1% by weight.
 - .6 Label bags legibly with correct name and size of chip.
- .6 Flexible Epoxy Membrane: MasterFlex Flexible Epoxy Membrane, 100% solids with the following properties:
 - .1 Tensile Strength, ASTM D2370, 20° C: 10.3 Mpa.
 - .2 Elongation, ASTM D2370, 20° C: 130%
- .7 Primer: Morricite Primer, 100% solids, moisture insensitive. No solvent containing primers are allowed.
- .8 Epoxy Slope and Fill Mortar: 100% Solids fill mortar system including blended aggregate.
- .9 Divider-Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use and acceptable to terrazzo manufacturer.
- .10 Finishing Grout: Morricite Terrazzo Grout, 100% Solids.
- .11 Control Joint Filler: MTT ColorFlex 100% Solids Flexible, Grindable Epoxy Joint Filler in colour selected by Consultant to match/compliment terrazzo with the following properties:
 - .1 Tensile Strength: ASTM D2370 @ 20° C: 11.03 mPA.
 - .2 Elongation: ASTM D2370 @ 20° C: 100%

- .3 Tensile Modulus: ASTM D2370 @ 20° C: 191.67 Mpa.
- .12 Seal Coat: Thin-coat terrazzo sealer of or approved by terrazzo manufacturer.
- .13 Mix: Comply with TTMAC Specification Guide 09 30 00 and manufacturer's written instructions for component proportions and mixing.
- .14 Colour and Pattern Schedule: Provide specified terrazzo matrices matching existing terrazzo flooring.

2.3 Divider and Accessory Strips

- .1 Thin-Set Divider Strips: Angle or T Type.
 - .1 Material: White zinc alloy, half hard brass, plastic in colour selected from manufacturers product range.
 - .2 Top Width: 1.6 mm.
- .2 Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material, thickness, and colour of divider strips and in depth required for topping thickness indicated. 1.60 mm x 9.5 mm with MTT ColorFlex flexible sealant).
- .3 Accessory Strips: Match divider-strip width, material, and colour unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
 - .1 Base bead and base dividers.
 - .2 Edge beads for exposed edges of terrazzo.
- .4 Anchoring Strips: Adhere the strips to the floor with Morricite Primer or hot glue. Do not mechanically anchor.
- .5 Apply clear lacquer to concealed bottoms, sides, and edges of extruded units set into terrazzo.

2.4 Accessories

- .1 Base: Poured in Place Terrazzo Cove Base with 19 mm radius, height to match existing.
- .2 Patching and Fill Material: MorriFill or MonoFill slope and fill mortar.
- .3 Abrasive Strips: Metal channels matching strips to receive epoxy and abrasive aggregate.
- .4 Joint Sealants:
 - .1 Control joints: ColorFlex.
 - .2 Expansion Joints; Sealant manufacturers complying with requirements in Section 07 92 00 - Joint Sealants.
- .5 Terrazzo Cleaner: TTMAC 1001, 1002, 1003, or 1104 as applicable. Terrazzo cleaner shall be biodegradable, phosphate free and shall have a pH factor between 7 and 10 and be of a type specially prepared for use on terrazzo. Free from crystallizing salts or water soluble alkaline salts. Submit maintenance instructions for bonded terrazzo.
- .6 Sealer: Colourless, liquid, penetrating type to completely seal cementitious matrix surface, specially prepared for use on terrazzo and not detrimental to terrazzo components. Sealer must be UL listed as slip resistant.

PART 3 EXECUTION

3.1 Examination

- .1 Examine substrates and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected.
- .2 Examine areas to receive terrazzo for:
 - .1 Defects in existing work that affect proper execution of terrazzo work.
 - .2 Deviations beyond allowable tolerances for the concrete slab work.
 - .3 Age (minimum 30 days) and moisture content of concrete slab. If concrete substrate moisture exceeds 80% according to ASTM F2170, consult terrazzo manufacturer for additional drying or negative side moisture mitigation methods.
- .3 Start work only when all defects are corrected.
- .4 Prior to system application, treat cracks with flexible membrane and fill substrate irregularities with Epoxy Fill and in accordance with manufacturer's recommendations.

3.2 Preparation

- .1 Clean substrates of substances that might impair epoxy terrazzo bond, including oil, grease, and curing compounds.
- .2 Provide clean, dry, and neutral substrate for terrazzo application. Determine dryness characteristics by performing moisture tests recommended by terrazzo manufacturer.
- .3 Concrete: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with epoxy terrazzo.
- .4 Prepare concrete substrate to "open" surface pores by means of vacuum shotblasting or with a terrazzo grinder, dry with coarse diamond stones with a vacuum unit. Surface preparation results should achieve a CSP3-CSP5 profile according to International Concrete Repair Institute Guideline No. 03732. Remove all contaminating or bond breaking substances including but not limited to dust, laitance, curing compounds, coatings, sealers, oil, grease and carpet or vinyl mastics or adhesives. Any oil or grease not removed by vacuum blasting must be chemically removed. All spalled or deteriorated concrete should be mechanically removed by scabbling or chipping hammers. Acid etching is not acceptable.
- .5 Repair or level damaged concrete with epoxy fill mortar. Latex fills or self-leveling underlayments are not acceptable.
- .6 Cracks and non-expansion joints greater than 1.6mm wide after surface preparation shall be prepared until sound.
- .7 Protect other work from dust generated by grinding operations. Control dust to prevent air pollution and comply with environmental protection regulations.
- .8 Erect and maintain temporary enclosures and other suitable methods to limit dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.3 Epoxy Terrazzo Installation with Crack Detailing

- .1 Comply with T.T.M.A.C. written recommendations for terrazzo and accessory installation.
- .2 Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions and T.T.M.A.C. Guide Specification for Epoxy Terrazzo.
- .3 Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.
- .4 Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.
- .5 Divider and Accessory Strips: Install in locations indicated in adhesive setting bed without voids below strips.
- .6 Control-Joint Strips: Install back to back directly over concrete control and now-doweled construction joints leaving a space appropriate for anticipated movement- typically 6.35 mm – 9.5 mm. Fill gap between control joints with flexible epoxy joint sealant.
- .7 Cracks and Non-Expansion Joints:
 - .1 Type 1: Hairline cracks shall be filled with epoxy primer and receive detail coat of epoxy primer with 150 mm fiberglass tape.
 - .2 Type 2: Fill cracks greater than hairline but less than 1.6mm wide after surface preparation with epoxy primer or MasterFlex Membrane. Place detail coat of Membrane over crack and embed 300 mm wide MasterFlex fabric. Lightly abrade or solvent wipe treated cracks prior to applying primer.
 - .3 Type 3: Fill cracks greater than 1.6mm with MasterFlex Membrane. Place 25-30 mil detail coat so that Membrane extends at least 230 mm to 300 mm on each side of crack or joint. After Membrane has leveled, lay precut MasterFlex Fabric into wet Membrane. Smooth cloth with a flat steel trowel, allowing cloth to be encapsulated but remain exposed on the surface of Membrane. Lightly abrade or solvent wipe treated cracks prior to applying primer.
- .8 Primer: Apply epoxy primer evenly over prepared substrate, cracks and non-expansion joints at the rate of 18 – 28 m² per 3.785 liters for normal concrete, to thoroughly wet surface, but avoiding "ponding" the material.
- .9 Placing Terrazzo:
 - .1 Mix terrazzo binder with chips and fillers in ratios as approved by manufacturer.
 - .2 Trowel apply terrazzo mixture over epoxy primer to provide smooth seamless surface at a minimum of 9.5 mm thick. Allow cure per manufacturer's recommendations prior to grinding operations.
 - .3 Rough Grinding: Grind with 24 or finer grit stones or with comparable diamond plates.
 - .4 Intermediate Grinding: Follow initial grind with 80 or finer grit stones.
- .10 Grouting: Cleanse floor with clean water and rinse thoroughly. Remove excess rinse water by wet vacuum and machine until completely dry. Apply epoxy grout to fill voids.
- .11 Fine Grinding: Grind with 120 grit stones until all grout is removed from surface. Repeat rough grinding, grout coat, and fine grinding if large voids exist after initial fine grinding. Produce surface with a minimum of 70 percent aggregate exposure.

- .12 Remove and replace terrazzo areas that show evidence of lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo.
- .13 Construction Tolerances: Limit variation in terrazzo surface from level to 6.0 mm in 3.0 metres.

3.4 Patching

- .1 In areas where removal work will leave terrazzo surfaces exposed, existing terrazzo floors shall be patched according to TTMAC recommendation. Where existing doors and frames and anchoring devices have been removed, holes shall be filled with grout and surface refinished to match existing terrazzo floor finish as required by Manufacturer's recommendation.
- .2 Where existing terrazzo floor surfaces are to be refinished in areas where doors and frames, etc. have been removed, remove all surface wax and/or sealer using solvent as recommended by TTMAC for such purpose prior to starting any refinishing work. Procedure as set forth for final grinding as specified hereinabove shall be followed unless otherwise recommended by TTMAC.

3.5 Refinishing Terrazzo Flooring and Base

- .1 All work shall be executed with conventional terrazzo grinding equipment according to trade practice. No lighter type machines, such as floor scrubbing machines, will be accepted.
- .2 Initial Grinding:
 - .1 Grind with 24 or finer grit stone (fine mesh sand can be used if needed) all in the presence of water.
 - .2 Follow initial grind with 80 or finer grit stones in the presence of water but omit sand.
- .3 Grouting:
 - .1 Cleanse floor with ample clean water and rinse.
 - .2 After removing excess rinse water, the floor shall be grouted by machine or by hand using identical cement/acrylic grout with colour and pigments to match the matrix of the existing terrazzo and as used in the existing topping taking care to fill voids.
After the grout has attained its initial set, the surface shall be cured for a minimum of 72
- .4 Curing Grout:
 - .1 The grout shall remain on the surface for a minimum of 72 hours.
- .5 Fine Grinding:
 - .1 Wash all surfaces with a neutral cleaner; follow by rinsing with clean water and allow to dry.
 - .2 Apply one coat of sealer, as per manufacturer's directions.
- .6 Cleaning and Sealing:
 - .1 Wash all surfaces with a neutral cleaner; follow by rinsing with clean water and allow to dry.
 - .2 Apply one coat of sealer, as per manufacturer's directions.
- .7 Protection:
 - .1 Upon completion, this Work shall be ready for final inspection and acceptance by the Consultant.
 - .2 Protect the finished floor from all trades that will follow using non-staining coverings

3.6 Protection

- .1 Upon completion, the work shall be ready for final inspection and acceptance by the Consultant. Protect the finished floor from the time the terrazzo installation is complete and until Substantial Performance.

3.7 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 03 30 00 Cast-in-Place Concrete

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM D638-22 Standard Test Method for Tensile Properties of Plastics
 - .2 ASTM D695-23 Standard Test Method for Compressive Properties of Rigid Plastics
 - .3 ASTM D2240-15(2021) Standard Test Method for Rubber Property—Durometer Hardness
 - .4 ASTM D4541-22 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
 - .5 ASTM F1869-23 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
 - .6 International Concrete Repair Institute (ICRI) ICRI Guideline 310.2 Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit manufacturer's product literature and application instructions.
- .3 Submit complete range of manufacturer's standard colours.
- .4 Provide maintenance data for epoxy flooring for incorporation into Operating and Maintenance Manuals specified in Section 01 78 00- Closeout Submittals.

1.5 Quality Assurance

- .1 Obtain primary resinous flooring materials, including primers, from resinous flooring manufacturer. Obtain secondary materials including aggregates, sheet flashings, joint sealants, and substrate repair materials of type and from source recommended by resinous flooring manufacturer.
- .2 Resinous flooring manufacturer shall have ISO 9001 Quality Certification.
- .3 Mock-Up:
 - .1 Prior to commencing epoxy flooring application, prepare a minimum 1.0 x 1.0 metre reference mock-up of each type, colour and texture of resinous flooring surface. Mock-up shall be constructed in location designated by Consultant, using the same equipment, tools and methods for installing all materials as will be used for the remaining work to be performed.
 - .2 Once accepted, mock-up is to remain, and is to be protected from damage. It shall become the standard for acceptance of colour and texture for resinous flooring applications.
 - .3 When Consultant determines that mockup does not meet requirements, demolish and remove it from the site and cast another until the mockup is accepted.

1.6 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

1.7 Project Conditions

- .1 Environmental Limitations: Apply resinous flooring within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply resinous flooring to damp or wet substrates, when temperatures are below 5 ° C, when relative humidity exceeds 70 percent, or when temperatures are less than -15 ° C above dew point.
 - .1 Coordinate flooring work with other trades to ensure adequate illumination, ventilation, and dust free environment during application and curing of flooring.
- .2 Coordinate flooring work with other trades to ensure adequate illumination, ventilation, and dust free environment during application and curing of flooring.
- .3 Conditions for Concrete
 - .1 New concrete shall be cured a minimum of 28 days before proceeding.
 - .2 Any cementitious repair mortars must have a full 7-day cure prior to coating.

1.8 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

1.9 Warranty

- .1 Warrant the work of this Section against defects of workmanship and material, for a period of two years from the date of Substantial Performance and agree to make good promptly any defects which occur or become apparent within the warranty period.

PART 2 PRODUCTS

2.1 Resinous Floor System

- .1 Resinous Floor System Primer: 2 component, 100% solids epoxy primer exhibiting the following characteristics:
 - .1 Mixed viscosity of 300 to 400 cps @ 75 ° F.
 - .2 Tack free time: 3 to 4 hours at 75 ° F. 50% RH
 - .3 Product: The Euclid Chemical Company; Dural Epoxy Primer
- .2 Resinous Floor System Base Coat: 2 component, 100% solids, novolac epoxy resin with the following characteristics:
 - .1 Compressive Strength: Minimum 9,000 to 10,000 psi per ASTM D695
 - .2 Shore D Hardness of 90 to 95 per ASTM D2240
 - .3 Tensile Strength 5,600 to 6,200 per ASTM D638
 - .4 Mixed Viscosity: 1,000 to 1,800 cps @ 75 ° F.
 - .5 Product:
 - .1 The Euclid Chemical Company; Duraltex 1805, www.euclidchemical.com
 - .2 Colour: To be chosen from manufacturer's list of standard colours.
- .3 Resinous Floor System Seal Coat: Utilize urethane coating recommended by resinous floor system base coat manufacturer.

- .4 Repair Mortar: Mortar mix of the 100% solids floor resin and aggregate.

PART 3 EXECUTION

3.1 Examination

- .1 Examine substrates, with Applicator present, for compliance with requirements and for other conditions affecting performance of resinous flooring.
- .2 For the record, prepare written report, endorsed by Applicator, listing conditions detrimental to performance.
- .3 Verify compatibility with and suitability of substrates.
- .4 Report, in writing, surfaces left in improper condition by other trades. Application of coating indicates acceptance of surfaces and conditions.

3.2 Surface Preparation

- .1 Clean and mechanically prepare substrates according to manufacturer's written recommendations to produce clean, sound, dust-free, dry, absorptive substrate free of grease, oils, curing compounds and other contaminants which may interfere with bond of resinous flooring. Surface profile should be equal to CSP2 to 5 in accordance with ICRI Guideline 310.2.
 - .1 Following surface preparation the cleaned concrete floor shall be tested for compliance with the following:
 - .1 Minimum surface tensile strength of 200 psi when tested per ASTM D4541.
 - .2 No vapour drive condition present when tested in accordance with ASTM F1869.
 - .2 Begin resinous flooring application only after minimum concrete curing and drying period recommended by resinous flooring manufacturer has passed, after unsatisfactory conditions have been corrected, and after surfaces are dry
- .2 Prepare vertical and horizontal surfaces at terminations and penetrations through resinous flooring and at expansion joints, drains, and sleeves according to manufacturer's written recommendations.
- .3 Mask adjoining surfaces not receiving resinous flooring, drains, and other substrate penetrations to prevent spillage, leaking, and migration of coatings.
- .4 Static Cracks and Non-Moving Joints shall be routed to a minimum width of 6 mm and a minimum depth of 13 mm and filled with a semi-rigid epoxy joint filler approved by resinous flooring manufacture or a detail coat of specified resinous floor coating.

3.3 Application

- .1 Resinous Floor System Monolithic Coating Application:
 - .1 Mechanical Mixing- Coating and primers shall be thoroughly mixed with a mechanical drill with a manufacturer approved mixing blade. Premix individual components separately per manufacturer's recommendations then combine materials and mix per manufacturers recommendations. Bottom and sides of container may be scraped during mixing but shall not be scraped once mixing has ceased. Do not aerate material.

- .2 Primer Application: Apply a uniform application of properly mixed, clear, resinous floor system primer to properly prepared substrate per manufacturer's recommendations. Allow 6 to 8 hours to, but no longer than 24 hours before proceeding.
- .3 Resinous Floor System Base Coat Application: Apply uniform application of properly mixed resinous floor system base coat to floor per manufacturer's instructions at coverage rates required to achieve 10 mils dry film thickness. Allow 5 to 8 hours but no more than 24 hours before applying additional coats. Repeat for second coat.
- .4 Resinous Floor System Seal Coat Application: Apply uniform application of properly mixed resinous floor system seal coat per manufacturer's written recommendations at manufacturer's recommended coverage rate.

3.4 Curing and Protection

- .1 Prevent contamination and damage during application and curing stages.
- .2 Protect resinous flooring from damage and wear during remainder of construction period.

3.5 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 08 11 00 Metal Doors and Frames
- .2 Section 09 21 16 Gypsum Board

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM A780/A780M-20 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- .2 Environmental Protection Agency (EPA)
 - .1 Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings).
- .3 Master Painters Institute (MPI)
 - .1 MPI Architectural Painting Specifications Manual, 2018
 - .2 MPI Standard GPS-1-12 and GPS-2-12 MPI Green Performance Standard for Painting and Coatings.
- .4 Society for Protective Coatings (SSPC)
 - .1 Systems and Specifications, SSPC Painting Manual 2009
- .5 Underwriters Laboratories of Canada (ULC)
 - .1 ULC 102-18 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
- .6 South Coast Air Quality Management District, California State (SCAQMD)
 - .1 SCAQMD Rule 1113-96, Architectural Coatings.
- .7 Green Seal GS-11 Green Seal Environmental Standard for Paints and Coatings, January 1997.
- .8 National Fire Code of Canada

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit full range colour sample chips.
 - .2 Submit duplicate 200 x 300 mm sample panels of each paint, stain, clear coating and special finish with specified paint or coating in colours, gloss/sheen and textures required to MPI Architectural Painting Specification Manual standards.
 - .3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties and SCAQMD Rule 1113-96.
- .5 Provide maintenance data for paint products for incorporation into Operating and Maintenance Manuals specified in Section 01 78 00- Closeout Submittals. Include following:
 - .1 Product name, number, type and use.

- .2 Colour numbers.
- .3 MPI Environmentally Friendly classification system rating.

1.5 Quality Assurance

- .1 Qualifications:
 - .1 Contractor: to have a minimum of five years proven satisfactory experience.
 - .2 Qualified journeypersons as defined by local jurisdiction to be engaged in painting work.
 - .3 Apprentices: may be employed provided they work under direct supervision of qualified journeyperson in accordance with trade regulations.
- .2 Conform to latest MPI requirements for painting work including preparation and priming.
- .3 Materials: in accordance with MPI Painting Specification Manual "Approved Product" listing and from a single manufacturer for each system used.
- .4 Paint materials to be highest quality product of an approved manufacturer listed in MPI Painting Specification Manual and to be compatible with other coating materials as required.
- .5 Retain purchase orders, invoices and documents to prove conformance with noted MPI requirements when requested by Consultant.
- .6 Provide mock-up in accordance with Section 01 45 00 - Quality Control.
 - .1 Prepare and paint designated surface, area, room or item (in each colour scheme) to specified requirements, with specified paint or coating showing selected colours, gloss/sheen and textures. Locate where directed.
 - .2 Mock-up will be used to judge workmanship, substrate preparation, operation of equipment and material application and workmanship to MPI Architectural Painting Specification Manual standards.
 - .3 Allow 24 hours for inspection of mock-up before proceeding with work.
 - .4 When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.

1.6 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver and store materials in original containers, sealed, with labels intact. Labels to indicate:
 - .1 Manufacturer's name and address.
 - .2 Type of paint or coating.
 - .3 Compliance with applicable standard.
 - .4 Colour number in accordance with established colour schedule.
- .3 Provide and maintain dry, temperature controlled, secure storage. Store materials and equipment in well-ventilated area with temperature range 7 ° C to 30 ° C. Store materials and supplies away from heat generating devices.
- .4 Observe manufacturer's recommendations for storage and handling.
- .5 Keep areas used for storage, cleaning and preparation, clean and orderly. After completion of operations, return areas to clean condition.
- .6 Remove paint materials from storage only in quantities required for same day use.

- .7 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.
- .8 Remove damaged, opened and rejected materials from site.

1.7 Fire Safety Requirements

- .1 Provide one 9 kg Type ABC dry chemical fire extinguisher adjacent to storage area.
- .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
- .3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.

1.8 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic in designated containers. Handle and dispose of hazardous materials in accordance with Municipal regulations.
- .3 Unused materials must be disposed of at official hazardous material collections site.
- .4 Paint and related materials are regarded as hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from the Ministry of the Environment.
- .5 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
- .6 Place materials defined as hazardous or toxic waste in containers or areas designated for hazardous waste.

1.9 Maintenance

- .1 Extra Materials:
 - .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Quantity: provide one four litre can of each type and colour of finish coating. Identify colour and paint type in relation to established colour schedule and finish system.
 - .3 Deliver to Owner and store where directed.

1.10 Ambient Conditions

- .1 Heating, Ventilation and Lighting:
 - .1 Ventilate enclosed spaces in accordance with Section 01 51 00 – Temporary Utilities.
 - .2 Provide heating facilities to maintain ambient air and substrate temperatures above 10 ° C for 24 hours before, during and after paint application until paint has cured sufficiently.
 - .3 Provide continuous ventilation for seven days after completion of application of paint.
 - .4 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
 - .5 Provide minimum lighting level of 323 Lux on surfaces to be painted.
- .2 Temperature, Humidity and Substrate Moisture Content Levels:

- .1 Unless pre-approved in writing by Consultant and product manufacturer, perform no painting when:
 - .1 Ambient air and substrate temperatures are below 10 ° C.
 - .2 Substrate temperature is above 32 ° C unless paint is specifically formulated for application at high temperatures.
 - .3 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.
 - .4 The relative humidity is under 85% or when the dew point is more than 3 ° C variance between the air/surface temperature. Paint should not be applied if the dew point is less than 3 ° C below the ambient or surface temperature. Use sling psychrometer to establish the relative humidity before beginning paint work.
- .2 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.
- .3 Perform painting work when maximum moisture content of the substrate is below:
 - .1 Allow new concrete to cure minimum of 28 days.
 - .2 15% for wood.
 - .3 12% for plaster and gypsum board.
- .4 Test for moisture using calibrated electronic Moisture Meter. Test concrete floors for moisture using "cover patch test".
- .5 Test concrete and plaster surfaces for alkalinity as required.
- .3 Surface and Environmental Conditions:
 - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
 - .2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.
 - .3 Apply paint when previous coat of paint is dry or adequately cured.

PART 2 PRODUCTS

2.1 Materials

- .1 Provide paint materials for paint systems from single manufacturer.
- .2 Products to meet requirements of GS-11 or SCAQMD Rule 1113-96
- .3 Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.
- .4 Only qualified products with E2 or E3 "Environmentally Friendly" rating are acceptable for use.
- .5 Linseed oil, shellac, and turpentine: highest quality product from approved manufacturer listed in MPI Architectural Painting Specification Manual, compatible with other coating materials as required.
- .6 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids:
 - .1 Non-flammable, biodegradable.
 - .2 Manufactured without compounds which contribute to ozone depletion in the upper atmosphere.
 - .3 Manufactured without compounds which contribute to smog in the lower atmosphere.
 - .4 Do not contain methylene chloride, chlorinated hydrocarbons or toxic metal pigments.
 - .5 Recycled content of 15% post-consumer and ½ post-industrial waste.
- .7 Formulate and manufacture water-borne surface coatings with no aromatic solvents,

formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

- .8 Flash point: 61 °C or greater for water-borne surface coatings and recycled water-borne surface coatings.

2.2 Colours

- .1 Consultant will provide Colour Schedule.
- .2 Colour schedule will be based upon selection of eight base colours and six deep tint accent colours.
- .3 Selection of colours will be from manufacturer's full range of colours.
- .4 Where specific products are available in restricted range of colours, selection will be based on limited range.
- .5 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 Mixing and Tinting

- .1 Perform colour tinting operations prior to delivery of paint to site.
- .2 Use and add thinner in accordance with paint manufacturer's recommendations. Do not use kerosene or similar organic solvents to thin water-based paints.
- .3 Thin paint for spraying in accordance with paint manufacturer's instructions.
- .4 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

2.4 Gloss/Sheen Ratings

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

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

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

SPEC NOTE: SEE <http://www.paintinfo.com/mpi/guide/fullspecREV.pdf> FOR FULL MPI SPECIFICATION

2.5 Interior Painting Systems

- .1 Concrete Horizontal Surfaces:
 - .1 INT 3.2A Latex floor enamel [gloss] [low gloss] finish.

- .2 Concrete Floor Sealer: Refer to Section 09 67 00-Fluid Applied Flooring.
- .2 Concrete Vertical Surfaces:
 - .1 Water repellant sealer as specified in Section 07 19 00 –Water Repellants.
- .3 Structural Steel:
 - .1 INT 5.1X Latex G5 semi-gloss finish (over quick dry shop primer).
- .4 Metal Fabrications:
 - .1 INT 5.3A Latex G5 semi-gloss finish
- .5 Metal Floors and Decking:
 - .1 INT 5.1LL Epoxy Deck Coating finish (over epoxy primer).
- .6 Zinc Coated Metal Deck:
 - .1 INT 5.3H. Interior Latex semi-gloss, dry fog/fall type.
- .7 Galvanized Metal: interior doors, frames, railings, misc. steel, pipes, and ducts.
 - .1 INT 5.3A Latex G5 semi-gloss finish
- .8 Concrete Masonry:
 - .1 INT 4.2D High performance architectural latex G5 semi-gloss finish.
- .9 Concrete masonry units at wet areas and change rooms:
 - .1 INT 4.2G Epoxy (tile-like) finish.
- .10 Wood Clear Polyurethane Finish:
 - .1 INT 6.3K Polyurethane varnish G6 gloss finish.
- .11 Interior Wood Doors
 - .1 INT 6.3A High performance architectural latex G5 semi-gloss finish.
- .12 Wood Fire Retardant Finish (ceilings and soffits)
 - .1 INT 6.3S water-borne fire retardant, clear finish, ULC approved. Flame spread rating 150.
- .13 Electrical Equipment Backboards:
 - .1 INT 6.4P Fire retardant, pigmented coating. Low odour/low VOC. Semi-gloss (UL/ULC rated).
- .14 Gypsum Board: Walls and Bulkheads.
 - .1 INT 9.2A Latex G3 eggshell finish over latex sealer.
- .15 Gypsum Board: Ceilings and Bulkheads (wet areas)
 - .1 INT 9.2E Epoxy (tile like) finish
- .16 Gypsum Board: Ceilings and Bulkheads:
 - .1 INT 9.2A Latex G2 velvet finish over latex sealer.
- .17 All other surfaces not noted above: high performance finish suitable for commercial and institutional environment and in accordance with MPI painting manual.

PART 3 EXECUTION

3.1 General

- .1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.
- .2 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and application instructions, and data sheets.

3.2 Examination

- .1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report damages, defects, unsatisfactory or unfavourable conditions to Consultant before proceeding with work.

3.3 Preparation

- .1 Protection:
 - .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking and in accordance with paint manufacturers and MPI recommendations. If damaged, clean and restore surfaces as directed by Consultant.
 - .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
 - .3 Protect factory finished products and equipment.
- .2 Surface Preparation:
 - .1 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
 - .2 Place "WET PAINT" signs in occupied areas as painting operations progress.
- .3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
 - .1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths, or compressed air.
 - .2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Allow surfaces to drain completely and allow to dry thoroughly.
 - .5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
 - .6 Use trigger operated spray nozzles for water hoses.
 - .7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water-based paints.
- .4 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.
- .5 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.
 - .1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.
 - .2 Apply wood filler to nail holes and cracks.
 - .3 Tint filler to match stains for stained woodwork.
- .6 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease

and other foreign substances in accordance with MPI requirements and SSPC-SP 6. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes blowing with clean dry compressed air or vacuum cleaning.

- .7 Touch up of shop primers with primer as specified.
- .8 Do not apply paint until prepared surfaces have been accepted by Consultant.

3.4 Application

- .1 Apply paint materials in accordance with paint manufacturer's written application instructions.
- .2 Brush and Roller Application:
 - .1 Apply paint in uniform layer using brush and/or roller type suitable for application.
 - .2 Work paint into cracks, crevices and corners.
 - .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
 - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.
 - .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Spray application:
 - .1 Provide and maintain equipment that is suitable for intended purpose, capable of atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - .2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.
 - .3 Apply paint in uniform layer, overlapping at edges of spray pattern. Back roll first coat application.
 - .4 Brush out immediately all runs and sags.
 - .5 Use brushes and rollers to work paint into cracks, crevices and places which are not adequately painted by spray.
- .4 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- .5 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .6 Sand and dust between coats to remove visible defects.
- .7 Finish surfaces both above and below sight lines as specified for surrounding surfaces.
- .8 Finish alcoves as specified for adjoining rooms.
- .9 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.5 Mechanical/Electrical Equipment

- .1 Paint finished area exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and finish to match adjacent surfaces.
- .2 Mechanical and electrical rooms: paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment.

- .3 Other unfinished areas: leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.
- .4 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.
- .5 Do not paint over nameplates.
- .6 Keep sprinkler heads free of paint.
- .7 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matt black paint.
- .8 Paint fire protection piping red.
- .9 Paint natural gas piping yellow.
- .10 Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.
- .11 Do not paint interior transformers and substation equipment.

3.6 Field Quality Control

- .1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .2 Standard of Acceptance:
 - .1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.
 - .2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
 - .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

3.7 Cleaning and Restoration

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.
- .3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to approval of Consultant. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Consultant.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 09 21 16 Gypsum Board

1.3 References

- .1 ASTM International (ASTM)
 - .1 ASTM A653/A653M-23 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - .2 ASTM A924/A924M-22a Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
 - .3 ASTM B456-17(2022) Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium
 - .4 ASTM C1503-18 Standard Specification for Silvered Flat Glass Mirror
 - .5 ASTM D1187/D1187M-97(2018) Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.81-M90 Air Drying and Baking Alkyd Primer for Vehicles and Equipment.
 - .2 CAN/CGSB-1.88-92 Gloss Alkyd Enamel, Air Drying and Baking.
- .3 CSA Group (CSA)
 - .1 CSA/ASC B651:23 Accessible Design for the Built Environment.
 - .2 CSA G164-18(R2023) Hot Dip Galvanizing of Irregularly Shaped Articles.

1.4 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings:
 - .1 Indicate size and description of components, base material, surface finish inside and out, hardware and locks, attachment devices, description of rough-in-frame, building-in details of anchors for grab bars.
- .3 Samples:
 - .1 Submit samples when requested.
 - .2 Samples to be returned for inclusion into work.
- .4 Closeout Submittals:
 - .1 Provide maintenance data for toilet and bath accessories for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.

1.6 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

1.7 Extra Materials

- .1 Provide special tools required for accessing, assembly/disassembly or removal for toilet and bath accessories in accordance with requirements specified in Section 01 78 00 - Closeout Submittals.
- .2 Deliver special tools to Owner.

PART 2 PRODUCTS

2.1 Materials

- .1 Sheet steel: to ASTM A653 with ZF001 designation zinc coating.
- .2 Stainless steel sheet metal: Type 304, with Brushed finish.
- .3 Stainless steel tubing: Type 304, commercial grade, seamless welded, minimum 1.2 mm wall thickness.
- .4 Fasteners: concealed screws and bolts hot dip galvanized, exposed fasteners to match face of unit. Expansion shields fibre, lead or rubber as recommended by accessory manufacturer for component and its intended use.

2.2 Manufacturers

- .1 Products and components listed are minimum standard of acceptance. Alternative products by recognized manufacturers of toilet and bath accessories may be accepted subject to review by the Consultant of manufacturer's product information and specifications.
- .2 Acceptable manufacturers include:
 - .1 Bobrick
 - .2 Bradley
 - .3 Frost
 - .4 Hafele
 - .5 Watrous

2.3 Components

- .1 TPD: Toilet Tissue Dispenser:
 - .1 Supplied by Owner, installed by Contractor.
- .2 SD: Soap Dispenser: Liquid wall mounted soap dispenser.
 - .1 Supplied by Owner, installed by Contractor.
- .3 Hand Dryer:
 - .1 World Dryer SLIMdri Automatic touchless hand dryer surface mounted ADA compliant White Aluminum, 120-240V.
- .4 GB1: Grab Bar, 38 mm diameter x 1.6 mm wall tubing of stainless steel, 76 mm diameter wall flanges, concealed screw attachment, flanges welded to tubular bar, provided with steel back plates and all accessories. Knurl bar at area of hand grips. Grab bar material and anchorage to withstand downward pull of 2.2 kN. 600 mm long.
 - .1 Bobrick B-6806.99 x 24

- .5 GB2: Barrier Free Toilet Grab Bars 2 (L-shaped) 760 x 760 38 mm dia. Peened finish c/w mounting kits.
 - .1 Bobrick B-6898.99, 90° Angle Grab Bar.
- .6 Framed Mirror:
 - .1 Bobrick B-1658 1830
- .7 SND: Sanitary Napkin Disposal
 - .1 Supplied by Owner, installed by Contractor.
- .8 Not used
- .9 Coat Hook:
 - .1 Bobrick B-983
- .10 Backrest: Bobrick B-5892
- .11 Recessed Napkin Dispenser:
 - .1 Supplied by Owner, installed by Contractor.

2.4 Fabrication

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

2.5 Finishes

- .1 Chrome and nickel plating: to ASTM B456, satin finish.
- .2 Baked enamel: condition metal by applying one coat of metal conditioner to ASTM D1187, apply one coat Type 2 primer to CAN/CGSB-1.81 and bake, apply two coats Type 2 enamel to CAN/CGSB-1.88 and bake to hard, durable finish. Sand between final coats. Colour selected from standard range by Consultant.
- .3 Manufacturer's or brand names on face of units not acceptable.

Project: 25233
Description: BROCK HIGH SCHOOL RENOVATIONS

TOILET AND BATH ACCESSORIES
Section 10 28 10

PART 3 EXECUTION

3.1 Installation

- .1 Install toilet and bath accessories in accordance with the Ontario Building Code, CSA B651 and manufacturer's instructions.
- .2 Install and secure accessories rigidly in place as follows:
 - .1 Stud walls: install steel back-plate to stud prior to plaster or drywall finish. Provide plate with threaded studs or plugs.
 - .2 Hollow masonry units or existing plaster/drywall: use toggle bolts drilled into cell/wall cavity.
 - .3 Solid masonry or concrete: use bolt with lead expansion sleeve set into drilled hole.
- .3 Install grab bars on built-in anchors provided by manufacturer.
- .4 Use tamper proof screws/bolts for fasteners.
- .5 Fill units with necessary supplies shortly before final acceptance of building.
- .6 Install products in strict compliance with manufacturer's written instructions and recommendations, including the following:
 - .1 Verify blocking has been installed properly.
 - .2 Verify location does not interfere with door swings or use of fixtures.
 - .3 Comply with manufacturer's recommendations for backing and proper support.
 - .4 Use fasteners and anchors suitable for substrate and project conditions.
 - .5 Install units rigid, straight, plumb, and level, in accordance with manufacturer's installation instructions and approved shop drawings.
 - .6 Conceal evidence of drilling, cutting, and fitting to room finish.
 - .7 Test for proper operation.
- .7 Install electric hand dryers according to manufacturer's instructions. Installation shall be by an electrician and shall be completed in accordance with all relevant standards and Codes.

3.2 Schedule

- .1 Locate accessories where indicated. Exact locations determined by Owner.

3.3 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 Clean exposed surfaces of compartments, hardware, and fittings using methods acceptable to the manufacturer.
- .3 Touch-up, repair or replace damaged products until Substantial Performance.

End of Section

PART 1 GENERAL

1.1 General

- .1 Conform to the requirements of Division 1.

1.2 Related Sections

- .1 Section 06 10 00 Rough Carpentry

1.3 Submittals

- .1 Make submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit manufacturer's preprinted technical literature for pre-manufactured products.

1.4 Shipping, Handling and Storage

- .1 Refer to Section 01 61 00 – Common Product Requirements.
- .2 Deliver, handle and store materials in accordance with manufacturer's printed instructions.
- .3 Protect finished surfaces during shipment and installation.

1.5 Waste Management and Disposal

- .1 Refer to Section 01 74 19 – Construction Waste Management and Disposal.

PART 2 PRODUCTS

2.1 Materials

- .1 Items specified herein shall be standard manufactured items, modified if required and as specified to suit conditions of this project.
- .2 Thickness of metals shall be adequate for the various conditions with requirements specified as a minimum.
- .3 Finished work shall be free from warping, open seams, weld marks, rattles and other defects. Drilling shall be reamed and exposed edges finished smooth.
- .4 Provide all fastenings, anchorage and accessories as required to complete the work and as recommended by the manufacturer.

2.2 Products

.1 **Storage Cabinet**

- .1 U-Line H-6318GR Slim Storage Cabinet - 30 x 15 x 66", Unassembled, Light Gray
- .2 Steel construction with powder-coat finish.
- .3 Shelves adjustable in 51 mm increments.
- .4 Recessed locking latch.
- .5 Include 2 keys.

PART 3 EXECUTION

3.1 Installation - General

- .1 Install manufactured items in accordance with manufacturer's printed instructions and recommendations.

3.2 Cleaning

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.

End of Section

LIMITED DESIGNATED SUBSTANCE SURVEY REPORT (HVAC upgrades)



**Brock High School
Durham Regional Rd 12
Cannington, Ontario**

Presented to:

Durham District School Board
400 Taunton Road East
Whitby, Ontario
L1R 2K6

Attention: Patrick Cook

April 15, 2026

Maple Project No. 23079-1

EXECUTIVE SUMMARY

Maple Environmental Inc. ('Maple') was retained by Durham District School Board to perform a survey for Designated Substances as well as polychlorinated biphenyls (PCBs) and mould within the specified areas of Brock High School located at Durham Regional Rd 12, Cannington, Ontario (the 'Site'). It is our understanding that the building requires a survey to identify possible hazardous building materials that may be disturbed during the proposed HVAC upgrades of the specified areas.

The survey was limited to areas based on the architectural drawings prepared by RDZ ENGINEERS LTD on behalf of the Owner. The findings of the current survey are summarized below. Please refer to the main body of this report for details on all materials.

Asbestos

Asbestos-containing materials (ACM's) identified within the surveyed area at the time of the assessment are as follows:

- Drywall Joint Compound; Classrooms (102, 104, 203, 205 and 207)
- Masonry Primer; Mechanical Room (106), Corridor (360)
- Mechanical insulation; Mechanical Room (106)

It should be noted that due to the presence of solid walls and ceilings in the surveyed areas, access for viewing within the wall and ceiling cavities was not always possible. Suspect asbestos-containing materials may be present within wall and ceiling cavities that were not identified but are suspected to be present in this report. Caution should be taken when demolishing solid walls and ceilings within the areas being surveyed.

Lead

Based on the findings, the following general conclusions are made:

- Representative bulk samples of the predominant paint colours were collected which indicated the presence of low level lead paints (i.e. "virtually safe") in the surveyed area.
- Representative bulk samples of mortar were collected which indicated the presence of low level lead mortar (i.e. "virtually safe") in the surveyed area.
- It should be noted that lead may also be present in wiring connectors, electric cable sheathing, solder joints on copper piping, ceramic glazes, lead sheeting, masonry mortar, and as sub-surface layers to the most recent paint layers currently applied, where present at the Site.

Mercury

- Mercury vapour is present in all fluorescent light tubes.
- Liquid mercury is present in thermostat switches located within the surveyed area.

Silica

- Free crystalline silica, present as common construction sand, is present in all concrete and masonry products where present within the surveyed areas.

Mould

- No visible mould growth was observed to be present within the surveyed area at the time of the assessment.

- It is possible that mould growth is present in concealed areas such as wall or ceiling cavities, pipe chases, etc. or in areas not currently assessed by Maple. The client should notify Maple should any water damage or suspect mould growth be discovered.

Polychlorinated Biphenyls (PCBs)

- The fluorescent lamp fixtures observed contained a combination of T8 and T12 fluorescent light tubes. T12 fixtures are older fixtures and have the potential of using PCB-containing ballast. T8 fixtures have electronic ballast and are considered as not containing PCB.

Recommendations

Based on the Laboratory Analytical Results and observations made on Site, Maple provides the following recommendations.

- Remove all asbestos-containing materials that may be disturbed during the planned renovation using the appropriate asbestos abatement procedures as outlined in Section 5.0 of the Report.
- Low Level Lead paints and mortar (0.1% or less or 1000 mg/Kg or less) are considered virtually safe provided that;
 - airborne lead concentrations are kept below 0.05 mg/m³
 - general dust suppression and worker hygiene procedures are utilized
 - torching or other activities that create fumes are not completed
- Further, prior to disposal it is recommended that materials containing lead should be sampled and analyzed for Metals/Inorganics using the Toxicity Characteristic Leaching Procedure (TCLP) as described under O. Reg. 347. The testing is required to determine waste classification in accordance with Ontario Regulation 347 of R.R.O. 1990 made under the Environmental Protection Act amending Reg. 558/00.
- Recycle and reclaim mercury from fluorescent light tubes and thermostats when taken out of service. Do not break lamps or separate liquid mercury from components. Liquid mercury is classified as a hazardous waste and must be disposed of in accordance with local regulations.
- Proper dust suppression techniques and other safety precautions to control possible generation of silica dust from the demolition of concrete and masonry products present in the surveyed area should follow those outlined in the Ministry of Labour Guideline- Silica on Construction Projects, 2004.
- Should light fixtures containing ballasts be removed as part of the project, all ballasts not clearly marked as "non-PCB" on the label should be separated, handled and disposed of as PCB-containing or inspected by competent persons to ascertain PCB content.

Appropriate procedures for asbestos, lead, mercury, silica, mould, and PCBs must be utilized if these materials are likely to be disturbed by scheduled renovations. Please refer to Section 5.0 of the report to review the required procedures.

Consideration should be given to assessing other areas of the building that could be associated with the current project, including travel path, mechanical or electrical ties in the areas outside of the immediate project area, and penetrations through the slab impacting floors below or above.

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1.0 INTRODUCTION

Maple Environmental Inc. ('Maple') was retained by Durham District School Board to perform a survey for Designated Substances as well as polychlorinated biphenyls (PCBs) and mould within the specified areas of Brock High School located at Durham Regional Rd 12, Cannington, Ontario (the 'Site'). It is our understanding that the building requires a survey to identify possible hazardous building materials that may be disturbed during the proposed HVAC upgrades of the specified areas

The survey was limited to areas based on the architectural drawings prepared by RDZ ENGINEERS LTD on behalf of the Owner

Section 30 of the Ontario Occupational Health and Safety Act requires that the following Designated Substances be included in a Designated Substance Survey:

Asbestos

Lead

Mercury

Silica

Isocyanates

Vinyl Chloride Monomer

Benzene

Acrylonitrile

Coke Oven Emissions

Arsenic

Ethylene Oxide

Additional detailed information with respect to asbestos was collected at the time of the survey to ensure compliance with Ontario Regulation 278/05.

The assessment was performed by Nirmal Soni of Maple on March 18-19, 2026.

2.0 APPLICABLE ONTARIO REGULATIONS

Applicable Ontario Regulations for each of the materials included in the investigation are briefly described below.

2.1 Designated Substances and Other Hazardous Materials

Section 30 of the Occupational Health and Safety Act requires building owners or their agents (architects, general contractors, etc.) to prepare or have prepared a Designated Substance report for specified potentially hazardous materials possibly present in a facility. The owner must ensure that a prospective constructor has received a Designated Substance report before entering into a binding contract with the contractor. The owner is liable to the contractor for damages and costs arising from unreported materials (of which the owner should reasonably have been aware), and could also be subject to orders and fines from the Ministry of Labour.

In addition to the requirements under the Occupational Health and Safety Act, Section 6 of the Ministry of Labour Regulations for Construction Projects requires the contractor, when submitting the Notice of Project form, report any Designated Substances likely to be used, handled or disturbed during the project.

The disturbance of asbestos materials on construction projects is controlled by Ministry of Labour Regulation R.R.O. 2005/278. The disposal of asbestos waste is controlled by Ministry of Environment Regulation, R.R.O. 1990/347.

There are no specific Ministry of Labour regulations for control of the other Designated Substances on construction projects. However, the Ministry of Labour actively enforces the general duty clause of the Health and Safety Act which protects

workers and provides guidance on exposure monitoring, permissible exposure levels, medical monitoring, etc. for all Designated Substances.

Although Regulations exist for many of the Designated Substances, they apply to industry settings using Designated Substances in manufacturing processes, and do not apply to general property management, renovation or maintenance of buildings.

Polychlorinated Biphenyls ("PCBs") and mould were also included in the investigation, which are not specifically named as Designated Substances. No specific regulations are attached to these materials, but are generally governed by the due diligence section of the Health and Safety Act for employers to protect their workers.

2.2 Ontario Regulation 278/05 (Asbestos)

Ontario Regulation 278/05 applies to buildings with regards to maintenance, renovations or demolition work where asbestos-containing materials (ACM) is present and may be disturbed. The Regulation requires that a detailed asbestos inventory be performed in all buildings where friable and non-friable asbestos materials are present. The inventory must be available at the work place and must identify the type of asbestos, and location of asbestos on a room-by-room basis. The following report does not necessarily meet the requirements for an asbestos survey under Ontario Regulation 278/05.

2.3 Ontario Regulation 347

Ontario Regulation 347 applies to the transport of waste from the location of generation to a landfill site authorized to receive specific wastes. The regulation also prescribes procedures on how the specific wastes are to be handled at the landfill site.

The major requirements of the building owner and the person(s) removing the waste are to ensure that:

- The waste is appropriately packaged and labelled;
- The transport vehicle is appropriately placard; and
- The waste is to be transported as directly as possible to the landfill site once it leaves the site.

Some wastes require the owner to register a Generator (of waste) number and many wastes require classification that can restrict or even prohibit their disposal in landfill.

It is important to note that the building owner can be held responsible for the waste until the waste disposal site accepts it.

2.4 Ontario Regulation 362

Ontario Regulation 362, made under the Ontario Environmental Protection Act applies to the waste management and transport of PCB waste from the location of generation to a landfill site authorized to receive specific wastes. The regulation also prescribes procedures on how the specific wastes are to be handled at the landfill site.

3.0 SURVEY SCOPE AND METHODOLOGY

The methodology for the assessment for hazardous materials is outlined below.

In order to determine the location of materials included in the assessment, the project technologist entered the room where practical (i.e. where access was possible without the demolition of walls, roof or ceilings or destruction of flooring). Representative views were made above accessible suspended ceiling systems. Cavities within solid ceiling and wall systems were accessed via existing access panels only. The inventory did not include demolition of building systems or finishes to check on possible hidden conditions.

3.1 Asbestos-Containing Building Materials (ACM)

The scope of the survey included all friable asbestos products and all major non-friable asbestos materials. The term friable is applied to a material that can be readily reduced to dust or powder by hand or moderate pressure. Asbestos materials that are friable have a much greater potential to release airborne asbestos fibres when disturbed.

Typical friable asbestos materials include: sprayed fireproofing or thermal insulation, textured (stippled) plaster, and thermal mechanical insulation. Typical non-friable materials include: asbestos cement (transite) products, vinyl floor tiles, asbestos textiles and gaskets. Additional materials such as ceiling tiles, drywall joint compounds and vinyl sheet flooring are classified as non-friable, but because of their ability to release dust when disturbed are considered as "potentially friable" for the purpose of this report.

Bulk samples of materials suspected to contain asbestos were collected for analysis during the survey. Specifically, a small volume of material was removed either from a damaged section of suspect material, or taken from intact material. In these latter cases, the material from which the sample was collected was sealed with tape to temporarily prevent fibre release. Samples were placed in plastic bags and sealed until receipt by an independent laboratory. To ensure quality results, the independent laboratory chosen successfully participates in an "Asbestos Proficiency Analytical Testing Program". As such, these independent laboratories are responsible for their findings.

Bulk samples were collected in accordance with regulatory sampling requirements and with sufficient frequency to obtain a general pattern of asbestos use within the building. Due to building renovations or modifications that may have occurred in the past, the consistency of the application of asbestos materials may not be uniform throughout the entire Site. It is important to note that without sampling each individual wall, pipe section, ceiling tile etc. it is not possible to identify the asbestos content of every material present in the selected areas. For this reason, visually similar materials are considered to be homogenous with those already sampled elsewhere in the building without additional analysis.

O. Reg. 278/05 prescribes that a minimum number of samples be collected of materials suspected to contain asbestos. These minimum sampling requirements are summarized in Table 1, below.

Table 1- Suspect ACM Bulk Sampling Requirements		
Type of Material	Quantity of Material Present	Minimum # of Bulk Samples Required
Surfacing Materials (i.e. sprayed fireproofing, drywall joint compound, texture coat, and plaster)	Up to 90 sq/m (1000 sq/ft)	3
	From 90 sq/m (1000 sq/ft) to 450 sq/m (5000 sqft)	5
	Greater than 450 sq/m (5000 sq/ft)	7
All other potential ACM	Any	3

Excluding surfacing materials, the laboratory was instructed to cease analysis within Sample Groups of homogenous materials when one of the samples in the group is found to contain asbestos. For example, if three samples of a type of vinyl floor tile are collected (as required by O. Reg. 278/05) and submitted for analysis and the first sample is positively identified as containing asbestos, the balance of the sample group is not analysed.

EMC Scientific ("EMC"), an independent laboratory, was selected to analyse the collected bulk suspect asbestos samples. EMC successfully participates in an "Asbestos Proficiency Analytical Testing Program" and as such, is responsible for its findings. EMC followed the Code of Practice for the identification of asbestos in bulk material, as detailed in O. Reg. 278/05. Bulk samples were analysed using the Polarized Light Microscopy ("PLM") Technique with Dispersion Staining. The identification of asbestos fibre in bulk material is based on a collective set of parameters dependent on the unique shape and crystallographic properties of each fibre as viewed through the microscope. This method is useful for the qualitative identification of asbestos and the semi-quantitative determination of asbestos content in bulk materials expressed as a percent of projected area. The method identifies types of asbestos and also measures percent of asbestos as perceived by the analyst in comparison to standard area projections or trained experience.

The recommendations made as part of this report with respect to asbestos have taken into consideration: the condition and accessibility of the material, vibration, air movement, and general activities likely to occur within the vicinity of the ACM.

In each area or room inventoried, the technician recorded the quantity, condition (GOOD, FAIR, or POOR) of each suspect asbestos-containing material.

The definitions for condition and accessibility of the asbestos-containing items are as follows:

GOOD	Material is intact with no visible signs of damage.
FAIR	Material is visibly damaged but can be repaired.
POOR	Material is damaged beyond repair and likely needs to be removed.

Where ACM is found to be in GOOD condition and not likely to deteriorate or fall, the general recommendation would be to re-evaluate the condition of the material on an annual basis (required by O. Reg. 278/05). This recommendation can be subject to change if the material is located in a manner that persons untrained in asbestos awareness could physically damage it.

Where ACM is found to be damaged (i.e. FAIR or POOR condition), a recommendation to have the material cleaned-up, repaired, removed, enclosed, or encapsulated is offered. The recommendation will also indicate which asbestos procedure should be used to perform the remedial work (i.e. Type 1, Type 2, Type 3, or Glove Bag Removal Methods).

3.2 Lead

The investigation included the collection and analysis of all major paint colour applications for the presence of lead in the paint. Other materials that possibly contain lead were identified by known historic use, where relevant. For the purpose of this report, sampling for lead in mortar was also performed. The lead samples were analysed by EMSL Canada ("EMSL"), using atomic absorption spectrophotometry. EMSL is AIHA (American Industrial Hygiene Association) and NIOSH (National Institute of Occupational Safety and Health) accredited for this type of analysis. The Laboratory Analysis Report for lead in paint samples is included with this Report as Appendix II.

3.3 Mercury

The assessment included a visual identification of fluorescent light tubes, switches, electrical controls, heating system thermostats, thermometers, and other components historically known to contain mercury.

3.4 Other Designated Substances

Other materials listed in Section 1.0 of this Report were identified on a visual basis where present, as part of the current assessment. It should be noted that no manufacturing or heavy industrial activities are known by Maple to occur at the Site. Therefore, Designated Substances associated with these activities (i.e. those other than Asbestos, Lead, Mercury, and Silica) would not be expected to be present in the selected areas.

3.5 Mould

The assessment for mould was conducted in accordance with standard industry practice as set out in the Canadian Construction Association (CCA) "Mould Guidelines for the Canadian Construction Industry" for a visual assessment. Although there are no regulatory requirements in Ontario for such an assessment, the CCA Guidelines, and similar guidelines from other agencies have been accepted as the industry standard by most experts, consultants, the Ontario Ministry of Labour, and the Canadian Construction Association.

All guidelines and protocols for mould investigations indicate that investigations should be performed largely on a visual basis with limited collection of bulk and/or air samples. The Ontario Ministry of Labour has consistently enforced the removal of all mould from buildings regardless of mould genus or species, and therefore bulk samples or air samples for confirmation of mould are not typically collected for investigative purposes where mould is visible.

3.6 Polychlorinated Biphenyls

Manufacturers labels/codes collected from fluorescent lamp ballasts suspected of containing Polychlorinated Biphenyls ("PCBs") are compared with Environment Canada's document titled "Identification of Lamp Ballasts Containing PCBs", which identifies PCB-containing ballasts.

3.7 Limitations and Omissions from Scope

Due to the nature of building construction some limitations exist as to the possible thoroughness of any building materials inventory. The field observations, measurements, and analysis are considered sufficient in detail and scope to form a reasonable basis for the findings presented in this report. Maple warrants that the findings and conclusions contained herein have been made in accordance with generally accepted evaluation methods in the industry and applicable regulations at the time of the performance of the inventory.

It is possible that conditions may exist which could not be reasonably identified within the scope of the inventory or which were not apparent during the Site investigation. Maple believes that the information collected during the investigation concerning the property is reliable. No other warranties are implied or expressed.

During a standard ACM inventory performed for the purposes of regulatory compliance, it is industry practice to exclude certain suspect asbestos-containing materials from sampling. These materials are often excluded from sampling due to the risk of compromising the health and safety of the technician, other building occupants, or the integrity of the systems with which these materials are associated. Examples of such materials include; elevator brakes, roofing felts and mastics, high voltage wiring, mechanical packing and gaskets, underground services or piping, fire-doors, window caulking and levelling compound. Where observed, these materials were presumed to be ACM.

3.8 Drawings

Drawings included in Appendix III will indicate the locations of any major applications of an asbestos-containing material with the exception of mechanical insulations, drywall, plaster finishes and transite (which cannot be accurately depicted on drawings). The information depicted on the drawings is not to scale and is only meant to provide a general representation of the locations of asbestos-containing materials.

4.0 INVENTORY FINDINGS

The findings of the survey are presented separately below for each of the eleven Designated Substances as well as microbial growth (mould), and polychlorinated biphenyls. Asbestos is further detailed by typical applications of asbestos.

4.1 Asbestos

The following is a brief discussion of the extent to which ACM was identified in the surveyed area. The discussion is organized under the headings of materials that are generally suspected of containing asbestos. The sample numbers refer to the laboratory analysis report presented as Appendix I and summarised in Table 2 below. Fifty-five (55) bulk samples were collected for the determination of asbestos content and submitted to the lab to be analysed. Due to the presence of more than one phase of material in some of the original samples the laboratory may have performed

multiple analyses for some samples. In addition, some of the samples may not have been analysed due to the positive confirmation of asbestos in a previous sample of the same material during analysis. As a result, a total of sixty-eight (68) samples were analyzed.

Table 2- Analysis Summary of Asbestos Bulk Samples			
Sample No.	Room Name	Sample Description	Result
S-01A	Classroom - 102 Construction -1951 (Wall)	Drywall Joint Compound - White, joint compound	None Detected
		Off white, joint compound	1% Chrysotile
S-01B	Classroom - 102 Construction -1951 (Wall)	Drywall Joint Compound - White, joint compound	None Detected
		Off white, joint compound	1% Chrysotile
S-01C	Classroom - 104 Construction -1951 (Wall)	Drywall Joint Compound - White, joint compound	None Detected
		Off white, joint compound	None Detected
S-01D	Classroom - 203 Construction -1951 (Wall)	Drywall Joint Compound - White, joint compound	None Detected
		Off white, joint compound	None Detected
		White, plaster	None Detected
S-01E	Classroom - 205 Construction -1951 (Wall)	White and off white, joint compound	None Detected
S-02A	Corridor - 149 Construction -1951 (Wall)	Plaster - White, joint compound	None Detected
		Off white, joint compound	None Detected
S-02B	Corridor - 149 Construction -1951 (Wall)	Plaster - White, joint compound	None Detected
		Off white, joint compound	None Detected
S-02C	Corridor - 149 Construction -1951 (Wall)	Plaster - White, plaster	None Detected
		Dark grey, plaster	None Detected
		White, plaster	None Detected
		Grey, plaster	None Detected
S-02D	Corridor - 217 Construction -1951 (Wall)	Plaster - Off white, joint compound	None Detected
		White, plaster	None Detected
		Beige, plaster	
S-02E	Corridor - 217 Construction -1951 (Wall)	Plaster - White, plaster	None Detected
		Beige, plaster	None Detected
S-03A	Classroom - 102 Construction - 1951 (Wall)	Concrete Block Mortar - Off white, primer	None Detected
		Grey, cementitious material	None Detected
S-03B	Classroom - 102 Construction - 1951	Concrete Block Mortar - Off white, primer	None Detected

Table 2- Analysis Summary of Asbestos Bulk Samples

Sample No.	Room Name	Sample Description	Result
	(Wall)	Grey, cementitious material	None Detected
S-03C	Classroom - 104 Construction - 1951 (Wall)	Concrete Block Mortar - Off white, primer	None Detected
		Grey, cementitious material	None Detected
S-04A	Corridor - 149 Construction -1951 (Ceiling)	Textured Plaster - Beige, plaster	<0.5% Tremolite
S-04B	Corridor - 149 Construction -1951 (Ceiling)	Textured Plaster - Beige, plaster	None Detected
S-04C	Corridor - 149 Construction -1951 (Ceiling)	Textured Plaster - Off white, primer	None Detected
		Light grey, plaster	None Detected
S-04D	Corridor - 217 Construction -1951 (Ceiling)	Textured Plaster - Beige, plaster	None Detected
S-04E	Corridor - 217 Construction -1951 (Ceiling)	Textured Plaster - Beige, plaster	None Detected
S-05A	Classroom - 203 Construction -1951	CT-01 - 1'x1' Ceiling tile with holes	None Detected
S-05B	Classroom - 205 Construction -1951	CT-01 - 1'x1' Ceiling tile with holes	None Detected
S-05C	Classroom - 207 Construction -1951	CT-01 - 1'x1' Ceiling tile with holes	None Detected
S-06A	Classroom - 102 Construction - 1951	Brown, mastic	None Detected
		Off white, cementitious material with fibres	None Detected
S-06B	Classroom - 102 Construction - 1951	Brown, mastic	None Detected
S-06C	Classroom - 104 Construction - 1951	Brown, mastic	None Detected
S-07A	Classroom - 102 Construction - 1951	CT-02 - 2'x4' Ceiling tile with Large fissures and pinholes	None Detected
S-07B	Classroom - 102 Construction - 1951	CT-02 - 2'x4' Ceiling tile with Large fissures and pinholes	None Detected
S-07C	Classroom - 104 Construction - 1951	CT-02 - 2'x4' Ceiling tile with Large fissures and pinholes	None Detected
S-08A	Mechanical Room - 106 Construction - 1958	Concrete Block Mortar - Green, primer	1% Chrysotile
		Grey, cementitious material	None Detected

Table 2- Analysis Summary of Asbestos Bulk Samples			
Sample No.	Room Name	Sample Description	Result
S-08B	Mechanical Room - 106 Construction - 1958	Concrete Block Mortar	Not Analyzed
S-08C	Mechanical Room - 106 Construction - 1958	Concrete Block Mortar	Not Analyzed
S-09A	Mechanical Room - 106 Construction - 1958 (Pipe Straight)	Cellulose pipe insulation - Brown, compressed fibrous material	None Detected
		Black, fibrous material with tar	80% Chrysotile
S-09B	Mechanical Room - 106 Construction - 1958 (Pipe Straight)	Cellulose pipe insulation	Not Analyzed
S-09C	Mechanical Room - 106 Construction - 1958 (Pipe Straight)	Cellulose pipe insulation	Not Analyzed
S-10A	Mechanical Room - 106 Construction - 1958 (Pipe Fittings)	Parging Cement	80% Chrysotile
S-10B	Mechanical Room - 106 Construction - 1958 (Pipe Fittings)	Parging Cement	Not Analyzed
S-10C	Mechanical Room - 106 Construction - 1958 (Pipe Fittings)	Parging Cement	Not Analyzed
S-11A	Corridor - 149 Construction -1958	Ceramic Block Mortar	None Detected
S-11B	Corridor - 149 Construction -1958	Ceramic Block Mortar	None Detected
S-11C	Corridor - 149 Construction -1958	Ceramic Block Mortar	None Detected
S-12A	Classroom - 105 Construction -1958 (Wall)	Drywall Joint Compound	None Detected
S-12B	Classroom - 105 Construction -1958 (Wall)	Drywall Joint Compound	None Detected
S-12C	Classroom - 107 Construction -1958 (Wall)	Drywall Joint Compound	None Detected
S-13A	Classroom - 310 Construction -1967 (Wall)	Drywall Joint Compound	None Detected
S-13B	Classroom - 310 Office Construction -1967 (Wall)	Drywall Joint Compound	None Detected

Table 2- Analysis Summary of Asbestos Bulk Samples			
Sample No.	Room Name	Sample Description	Result
S-13C	Classroom – 312 Construction -1967 (Wall)	Drywall Joint Compound	None Detected
S-13D	Classroom – 314 Construction -1967 (Wall)	Drywall Joint Compound	None Detected
S-13E	Classroom – 309 Construction -1967 (Wall)	Drywall Joint Compound	None Detected
S-13F	Classroom – 305B Construction -1967 (Wall)	Drywall Joint Compound	None Detected
S-13G	Classroom – 305 Construction -1967 (Wall)	Drywall Joint Compound	None Detected
S-14A	Corridor - 360 Construction -1967	Brick Mortar - Off white and grey, primer	0.5% Chrysotile
		Grey, off white and grey, cementitious material	<0.5% Chrysotile
S-14B	Corridor - 360 Construction -1967	Brick Mortar	Not Analyzed
S-14C	Corridor - 360 Construction -1967	Brick Mortar	Not Analyzed
S-15A	Classroom - 314 Construction - 1967	CT-03 - 1'x1' Ceiling tile with Large fissures and pinholes	None Detected
S-15B	Classroom - 315 Construction - 1967	CT-03 - 1'x1' Ceiling tile with Large fissures and pinholes	None Detected
S-15C	Classroom - 316 Construction - 1967	CT-03 - 1'x1' Ceiling tile with Large fissures and pinholes	None Detected

Asbestos-containing materials (ACM) are present in the form of drywall joint compound, masonry primer, parging cement (mechanical insulation) and Cellulose pipe (mechanical insulation). Details for all confirmed and suspect asbestos-containing materials are presented below under the headings of the most typical asbestos applications in buildings.

It should be noted that due to the presence of solid walls and ceilings in the surveyed areas, access for viewing within the wall and ceiling cavities was not always possible. Suspect asbestos-containing materials may be present within wall and ceiling cavities that were not identified but are suspected to be present in this report. Caution should be taken when demolishing solid walls and ceilings within the areas being surveyed.

4.1.1 Sprayed Fireproofing (Friable)

No sprayed fireproofing was identified within the surveyed area at the time of the assessment.

4.1.2 Thermal Mechanical Insulation (Friable)

Asbestos and non-asbestos mechanical insulations were identified in the surveyed area

Pipe Fittings:

Parging cement insulation on pipe fittings (which include elbows, valves, tees, hangers, etc.) was observed on pipe systems within the Mechanical Room – 106

Three (3) representative samples (Sample Set S-10) of parging cement were collected and analysed for determination of asbestos content. Analysis of Sample Set S-010 found that the material contains **80% Chrysotile asbestos**.

Asbestos-containing parging cement was observed to be in GOOD condition at the time of the assessment.

All other pipe fittings observed within the surveyed area were either insulated with non-asbestos fibreglass and PVC or were un-insulated.

Pipe Straights:

Layered paper insulation known as "Cellulose" was observed within the Mechanical Room – 106. Cellulose is historically found on cold water piping, drains, and in some instances on condensate return piping.

Three (3) representative samples (Sample Set S-09) of Cellulose pipe insulation were collected and analysed for determination of asbestos content. Analysis of Sample Set S-11 found that the Cellulose does not contain asbestos. However, Black tar associated with Cellulose pipe insulation was also analyzed as part of the analysis process which confirmed that the material contains **80% Chrysotile asbestos**.

Asbestos-containing Cellulose was observed to be in GOOD condition at the time of the assessment.

All pipe straights observed were either insulated with non-asbestos fibreglass and PVC or were un-insulated.

Duct Systems:

Duct systems observed throughout the surveyed area were observed to be either un-insulated or were insulated with foil-face fibreglass insulation which is not suspected to contain asbestos.

Mechanical Equipment:

Boilers, hot water tanks, and air handling units were observed to be externally un-insulated. Hot water tanks were observed to be insulated with fibreglass insulation which is not suspected to contain asbestos.

4.1.3 Texture Finish (Friable)

No textured finishes were identified within the surveyed area at the time of the assessment.

4.1.4 Acoustic Ceiling Tiles (Potentially Friable)

No asbestos-containing acoustic ceiling tile systems were identified within the surveyed area at the time of the assessment.

Four (4) visually distinct types of ceiling tile systems were observed in the surveyed area. A brief description of each type of ceiling tile is outlined below.

- CT-01 (1'x1' Ceiling tile with holes):

CT-01 was observed to be present in the classrooms (203, 205, 207).

Three (3) representative samples (Sample Set S-05) of CT-01 were collected and analyzed for determination of asbestos content. Analysis of Sample Set S-05 found that the material does not contain asbestos.

- CT-02 (2'x4' Ceiling tile with Large fissures and pinholes):

CT-02 was observed to be present in the classrooms (102, 104).

Three (3) representative samples (Sample Set S-07) of CT-02 were collected and analyzed for determination of asbestos content. Analysis of Sample Set S-07 found that the material does not contain asbestos.

- CT-03 (1'x1' Ceiling tile with Large fissures and pinholes):

CT-03 was observed to be present in the classrooms (311, 313-316).

Three (3) representative samples (Sample Set S-15) of CT-03 were collected and analyzed for determination of asbestos content. Analysis of Sample Set S-15 found that the material does not contain asbestos.

- CT-04 (2'x4' small Fissures and Pinholes):

CT-04 was observed to be present in the corridors (149, 360), community youth hub 105, classrooms (309, 310, 312).

No bulk samples of CT-04 were collected as a date stamp manufacture code (02/21/17) was present on the backside of the tile indicating that the tiles were recently manufactured and therefore not suspected to contain asbestos.

4.1.5 Vinyl Sheet Flooring (Potentially Friable)

No vinyl sheet flooring finishes were identified within the surveyed area at the time of the assessment.

4.1.6 Vinyl Floor Tile (Non-Friable)

No vinyl floor tile systems are anticipated to be disturbed by work of the proposed project. Therefore, no representative bulk samples were collected. Various vinyl floor tiles in the building are known to contain asbestos.

4.1.7 Asbestos Cement Products "Transite" (Non-Friable)

No transite cement products were observed to be present in the surveyed area at the time of the assessment. However, ACM Transite rainwater leaders have been identified in the building and may be present in concealed locations within the surveyed area.

4.1.8 Drywall Joint Compound (DJC) (Potentially Friable)

Asbestos-containing non-asbestos drywall joint compound was identified within the surveyed area at the time of the assessment.

Interior drywall finishes were present in the form of wall finishes throughout the majority of the surveyed area.

Fifteen (15) representative samples (Sample Sets S-01, S-12 and S-13) of drywall joint compound were collected and analyzed for determination of asbestos content. Analysis of Sample Set S-01, collected from 1951 construction vintage, found that two (2) of the samples (S-01A and S-01B) contained between **1% Chrysotile asbestos**. No asbestos was detected in samples S01C, S01D and S01E. However, Ontario Regulation 278/05 requires that all homogenous material be considered as "asbestos-containing" if one or more samples are found to contain asbestos. As such, all drywall joint compound is to be considered as "asbestos-containing" until sampling proves otherwise.

Analysis of Sample Sets S-12, collected from construction vintage 1958 and S-13, collected from construction vintage (1967) found that the material does not contain asbestos.

4.1.9 Plaster (Potentially Friable)

No asbestos-containing plaster finishes were identified within the surveyed area.

Two (2) visually distinct types of plaster finishes were observed in the surveyed area. A brief description of each type of plaster finish is outlined below.

- Smooth Plaster:

Smooth plaster was observed to be present in the form of wall finishes in corridor (149 and 217).

Five (5) representative samples (Sample Set S-02) of smooth plaster were collected and analyzed for determination of asbestos content. Analysis of Sample Set S-02 found that the material does not contain asbestos.

- Textured Plaster:

Textured plaster was observed to be present in the form of wall finishes in Corridor (149 and 217).

Five (5) representative samples (Sample Set S-04) of textured plaster were collected and analyzed for determination of asbestos content. Analysis of Sample Set S-04 found that the material does not contain asbestos. However, Analysis of Sample S-04A was found to contain <0.5% tremolite asbestos, O.Reg. 278/05 does not consider materials with less than 0.5% asbestos as an asbestos-containing material.

4.1.10 Vermiculite (Friable)

No vermiculite insulation was observed to be present within the surveyed area at the time of the assessment. It should be noted that loose fill vermiculite insulation can often be present within voids of masonry and possibly some pre-manufactured surveyed area components that would not be identified during the course of this assessment.

4.1.11 Other

- Concrete Block Mortar:

Concrete Block Mortar was observed to be present in the Classroom (102 and 104) and Mechanical Room 106.

Six (6) representative samples (Sample Sets S-03 and S-08) of Concrete Block Mortar were collected and analyzed for asbestos. Analysis of Sample Set S-03, collected from the Classroom (102 and 104) in the 1951 construction vintage found that the mortar does not contain asbestos.

Primer associated with mortar was also analyzed as part of the analysis process which confirmed that the material does not contain asbestos.

Analysis of Sample Set S-08, collected from the Mechanical Room (106) in the 1958 construction vintage found that the mortar does not contain asbestos.

Primer associated with mortar was also analyzed as part of the analysis process which confirmed that the material contains **1% Chrysotile asbestos**.

- Mastic Pucks

Mastic pucks were observed to be present in the Classroom (102 and 104)

Three (3) representative samples (Sample Set S-06) of mastic pucks were collected and analyzed for asbestos content. Analysis of Sample Set S-06 found that the material does not contain asbestos.

- Brick Mortar:

Brick mortar was observed to be present in the Corridor 360.

Three (3) representative samples (Sample Set S-14) of Brick mortar were collected and analyzed for asbestos content. Analysis of Sample Set S-14 found that the mortar contains <0.5% asbestos, O.Reg. 278/05 does not consider materials with less than 0.5% asbestos as an asbestos-containing material.

Primer associated with mortar was also analyzed as part of the analysis process which confirmed that the material contains **0.5% Chrysotile asbestos**.

4.2 Lead

Six (6) bulk paint samples and three (3) bulk mortar samples were collected for determination of lead content and submitted to EMSL for analysis during the assessment. The sample number refers to the Certificate of Analysis Report presented as Appendix II and summarised in Table 3 below.

Table 3– Analysis Summary of Lead Samples			
Sample No.	Locations	Sample Description	Result
Pb-01	Classroom - 102 (Wall)	Beige Paint	0.070 % wt
Pb-02	Classroom – 104 (Wall)	Concrete Block Mortar	68 mg/Kg
Pb-03	Classroom – 105 (Wall)	White Paint	<0.0064 % wt
Pb-04	Classroom – 105 (Wall)	Grey Paint	<0.0064 % wt

Table 3– Analysis Summary of Lead Samples			
Sample No.	Locations	Sample Description	Result
Pb-05	Corridor – 149 (Wall)	Ceramic Block Mortar	<32 mg/Kg
Pb-06	Classroom 311 (Wall)	Light Pink	0.010 % wt
Pb-07	Corridor 360 (Wall)	Brick Mortar	<130 mg/K
Pb-08	Automotive – 300 (Wall)	Black Paint	<0.0064 % wt
Pb-09	Store room – 357 (Wall)	Orange Paint	0.017 % wt

No regulations currently exist in Ontario defining the lower limit of lead-containing material. The Ontario Ministry of Labour (MOL) has issued a guideline for lead abatement, entitled Guideline – Lead on Construction Projects (2004) which is considered enforceable. The Guideline does not specify what constitutes a material as “lead-containing”. Instead, it outlines procedures based on the concentration of airborne lead encountered during removal, as well as provides procedures and/or specific operations for lead-containing material removal. However, the Environmental Abatement Council of Canada (EACC) Lead Guideline for Construction, Renovation, Maintenance or Repair document classifies paint as either Low-Level, Lead-Containing, or Lead-Based as follows:

Table 4- EACC Classification of Lead	
Concentration of Lead	Definition
0.1% or less <u>OR</u> 1000 mg/Kg or less	Low Level Lead (“Virtually Safe”)
Greater than 0.1% but less than 0.5% <u>OR</u> Greater than 1000 mg/Kg but less than 5000 mg/Kg	Lead-Containing
Greater than 0.5% <u>OR</u> Greater than 5000 mg/Kg	Lead-Based

Based on these criteria and the results of the sample analysis, All paints and mortar sampled are considered to be Low-Level Lead (“virtually safe”).

4.3 Mercury

Mercury vapour is present in all fluorescent light tubes.

Liquid mercury is also present in thermostat switches located within the surveyed area.

4.4 Silica

Free crystalline silica, present as common construction sand, is present in all concrete and masonry products where present in the Select areas surveyed.

4.5 Isocyanates

Free isocyanate compounds would not be expected to be found in a non-manufacturing facility.

4.6 Vinyl Chloride Monomer

Vinyl chloride monomer would not be expected to be found in a non-manufacturing facility.

4.7 Benzene

Benzene would not be expected to be found in a non-manufacturing facility.

4.8 Acrylonitrile

Acrylonitrile would not be expected to be found in a non-manufacturing facility.

4.9 Coke Oven Emissions

Coke oven emissions would not be expected to be found in a non-manufacturing facility.

4.10 Arsenic

Arsenic would not be expected to be found in a non-manufacturing facility.

4.11 Ethylene Oxide

Ethylene oxide would not be expected to be found in a non-manufacturing facility.

4.12 Mould

No visible mould growth was observed to be present within the surveyed area at the time of the assessment.

It is possible that mould growth is present in concealed areas such as wall or ceiling cavities, pipe chases, etc. or in areas not currently assessed by Maple. The client should notify Maple should any water damage or suspect mould growth be discovered.

4.13 Polychlorinated Biphenyls (PCBs)

The fluorescent lamp fixtures observed contained a combination of T8 and T12 fluorescent light tubes. T12 fixtures are older fixtures and have the potential of using PCB-containing ballast. T8 fixtures have electronic ballast and are considered as not containing PCB.

5.0 RECOMMENDATIONS

5.1 Asbestos

Asbestos-containing materials identified within the surveyed areas include the following:

- Drywall Joint Compound; Classrooms (102, 104, 203, 205 and 207)
- Masonry Primer; Mechanical Room (106), Corridor (360)
- Mechanical insulation; Mechanical Room (106)

General recommendations for each of the confirmed asbestos-containing materials are as follows:

- Removal or disturbance of asbestos-containing mechanical insulations requires the use of Type 2, Type 3, or Glove Bag Asbestos Procedures as appropriate for the work being performed.
- Removal or disturbance of **1m² or less** of drywall with asbestos-containing drywall joint compound requires the use of Type 1 Asbestos Procedures. Removal or disturbance of **more than 1m²** of the subject material(s) requires the use of Type 2 Asbestos Procedures.
- Removal or disturbance of asbestos-containing primer requires the use of Type 2, or Type 3 Asbestos Procedures depending on the method of removal employed by the contractor. Drilling into masonry wall with ACM primer should be completed using Type 2 procedures that includes power tools equipped with a HEPA vacuum attachment.

It is important to note that due to the presence of solid wall and ceiling systems, the assessment was not able to confirm or deny the presence of ACM within wall and ceiling cavities. The presence of concealed ACM should be assumed. It is possible that ACM is present that was not identified in this report.

This report should not be read or interpreted as a "scope of work". Detailed abatement specifications should be prepared for asbestos removal that will impact the scope of any future renovations.

5.2 Lead

Paints and mortar (0.1% or less and/or 1000 mg/Kg or less) sampled were found to be low level lead ("virtually safe").

Low Level Lead paints and mortar are considered virtually safe provided that;

- airborne lead concentrations are kept below 0.05 mg/m³
- general dust suppression and worker hygiene procedures are utilized
- torching or other activities that create fumes are not completed

Further, prior to disposal it is recommended that materials containing lead should be sampled and analyzed for Metals/Inorganics using the Toxicity Characteristic Leaching Procedure (TCLP) as described under O. Reg. 347. The testing is required to determine waste classification in accordance with Ontario Regulation 347 of R.R.O. 1990 made under the Environmental Protection Act amending Reg. 558/00.

5.3 Mercury

Recycle and reclaim mercury from fluorescent light tubes when taken out of service. Do not break lamps or separate liquid mercury from components. Liquid mercury is classified as a hazardous waste and must be disposed of in accordance with local regulations.

5.4 Silica

Proper dust suppression techniques and other safety precautions to control possible generation of silica dust from the demolition of concrete and masonry products present in the building should follow those outlined in the Ministry of Labour Guideline- Silica on Construction Projects, 2004.

5.5 Polychlorinated Biphenyls

Prior to disposal, all fluorescent lamp ballasts should be inspected and compared with Environment Canada's document titled "Identification of Lamp Ballasts Containing PCBs" for the presence of PCB's.

6.0 LIMITATIONS

Due to the nature of building construction some limitations exist as to the possible thoroughness of the subject investigation. The field observations are considered sufficient in detail and scope to form a reasonable basis for the findings presented in this report. Maple warrants that the findings and conclusions contained herein have been made in accordance with generally accepted evaluation methods in the industry and applicable regulations at the time of the performance of the assessment.

It is possible that conditions may exist which could not be reasonably identified within the scope of the investigation or which were not apparent during the site investigation. Maple believes that the information collected during the investigation period concerning the property is reliable. No other warranties are implied or expressed.

Information provided by Maple is intended for Client use ONLY. Any use by a third party, of reports or documents authored by Maple, or any reliance by a third party on or decisions made by a third party based on the findings described in said documents, is the sole responsibility of such third parties. Maple accepts no responsibility for damages suffered by any third party as a result of decisions made or actions conducted.

The liability of Maple or its staff will be limited to the lesser of the fees paid or actual damages incurred by the Client. Maple will not be responsible for any consequential or indirect damages. Maple will only be liable for damages resulting from negligence of Maple; all claims by the Client shall be deemed relinquished if not made within two years after last date of services provided.

Please contact Maple Environmental Inc. at (905) 257-4408 for inquiries regarding this project.

End of Report

Sincerely,

MAPLE ENVIRONMENTAL INC.
Environment, Health and Safety Consultants

Prepared By:



Nirmal Soni
Project Technician

Reviewed By:



Kyle Prosser
President

APPENDIX I
LABORATORY ANALYSIS REPORT - ASBESTOS

Laboratory Analysis Report

To:

Nirmal Soni
Maple Environmental Inc.
482 South Service Road East, Suite 116
Oakville, Ontario
L6J 2X6

EMC LAB REPORT NUMBER: A132317
Job/Project Name: DDSB, Brock HS, HVAC upgrades, Dsub
Analysis Method: Polarized Light Microscopy – EPA 600
Date Received: Mar 20/26 **Date Analyzed:** Mar 25, 26/26
Analyst: Elizabeth Mierzynski
Reviewed By: Malgorzata Sybydlo

No. of Phases Analyzed: 68
Job No: 23079-01
Number of Samples: 55
Date Reported: Mar 26/26

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)			
				Asbestos Fibres		Non-asbestos Fibres	Non-fibrous Material
S-01A	A132317-1	Drywall Joint Compound on Wall (Loc. Classroom - 102) Construction -1951	2 Phases: a) White, joint compound b) Off white, joint compound	ND Chrysotile	1		100 99
S-01B	A132317-2	Drywall Joint Compound on Wall (Loc. Classroom - 102) Construction -1951	2 Phases: a) White, joint compound b) Off white, joint compound	ND Chrysotile	1		100 99
S-01C	A132317-3	Drywall Joint Compound on Wall (Loc. Classroom - 104) Construction -1951	2 Phases: a) White, joint compound b) Off white, joint compound	ND ND			100 100
S-01D	A132317-4	Drywall Joint Compound on Wall (Loc. Classroom - 203) Construction -1951	3 Phases: a) White, joint compound b) Off white, joint compound c) White, plaster	ND ND ND			100 100 100
S-01E	A132317-5	Drywall Joint Compound on Wall (Loc. Classroom - 205) Construction -1951	White and off white, joint compound	ND			100
S-02A	A132317-6	Plaster Wall (Loc. Corridor - 149) Construction -1951	2 Phases: a) White, joint compound b) Off white, joint compound	ND ND			100 100
S-02B	A132317-7	Plaster Wall (Loc. Corridor - 149) Construction -1951	2 Phases: a) White, joint compound b) Off white, joint compound	ND ND			100 100
S-02C	A132317-8	Plaster Wall (Loc. Corridor - 149) Construction -1951	4 Phases: a) White, plaster b) Dark grey, plaster	ND ND			100 100

EMC LAB REPORT NUMBER: A132317

Client's Job/Project Name/No.: 23079-01

Analyst: Elizabeth Mierzynski

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)			
				Asbestos Fibres		Non-asbestos Fibres	Non-fibrous Material
			c) White, plaster d) Grey, plaster	ND ND			100 100
S-02D	A132317-9 ⁵	Plaster Wall (Loc. Corridor - 217) Construction -1951	3 Phases: a) Off white, joint compound b) White, plaster c) Beige, plaster	ND ND ND			100 100 100
S-02E	A132317-10 ⁵	Plaster Wall (Loc. Corridor - 217) Construction -1951	2 Phases: a) White, plaster b) Beige, plaster	ND ND			100 100
S-03A	A132317-11	Concrete Block Mortar (Loc. Classroom - 102) Construction - 1951	2 Phases: a) Off white, primer b) Grey, cementitious material	ND ND			100 100
S-03B	A132317-12	Concrete Block Mortar (Loc. Classroom - 102) Construction - 1951	2 Phases: a) Off white, primer b) Grey, cementitious material	ND ND			100 100
S-03C	A132317-13	Concrete Block Mortar (Loc. Classroom - 104) Construction - 1951	2 Phases: a) Off white, primer b) Grey, cementitious material	ND ND			100 100
S-04A	A132317-14 ⁶	Textured Plaster Ceiling (Loc. Corridor - 149) Construction -1951	Beige, plaster	Tremolite	<0.5		100
S-04B	A132317-15 ⁵	Textured Plaster Ceiling (Loc. Corridor - 149) Construction -1951	Beige, plaster	ND			100
S-04C	A132317-16	Textured Plaster Ceiling (Loc. Corridor - 149) Construction -1951	2 Phases: a) Off white, primer b) Light grey, plaster	ND ND			100 100
S-04D	A132317-	Textured Plaster Ceiling (Loc.	Beige, plaster	ND			100

EMC LAB REPORT NUMBER: A132317

Client's Job/Project Name/No.: 23079-01

Analyst: Elizabeth Mierzynski

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)			
				Asbestos Fibres		Non-asbestos Fibres	Non-fibrous Material
	17 ⁵	Corridor - 217) Construction -1951					
S-04E	A132317-18 ⁵	Textured Plaster Ceiling (Loc. Corridor - 217) Construction -1951	Beige, plaster	ND			100
S-05A	A132317-19	CT-01 – 1'x1' Ceiling tile with holes (Loc. Classroom - 203) Construction -1951	Brown, ceiling tile	ND		90	10
S-05B	A132317-20	CT-01 – 1'x1' Ceiling tile with holes (Loc. Classroom - 205) Construction -1951	Brown, ceiling tile	ND		90	10
S-05C	A132317-21	CT-01 – 1'x1' Ceiling tile with holes (Loc. Classroom - 207) Construction -1951	Brown, ceiling tile	ND		90	10
S-06A	A132317-22	Mastic Pucks on Concrete Deck (Loc. Classroom - 102) Construction -1951	2 Phases: a) Brown, mastic b) Off white, cementitious material with fibres	ND ND		40	100 60
S-06B	A132317-23	Mastic Pucks on Concrete Deck (Loc. Classroom - 102) Construction -1951	Brown, mastic	ND			100
S-06C	A132317-24	Mastic Pucks on Concrete Deck (Loc. Classroom - 104) Construction -1951	Brown, mastic	ND			100
S-07A	A132317-25	CT-02 – 2'x4' Ceiling tile with Large fissures and pinholes (Loc. Classroom - 102) Construction - 1951	Grey, ceiling tile	ND		75	25

EMC LAB REPORT NUMBER: A132317

Client's Job/Project Name/No.: 23079-01

Analyst: Elizabeth Mierzynski

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)			
				Asbestos Fibres		Non-asbestos Fibres	Non-fibrous Material
S-07B	A132317-26	CT-02 – 2'x4' Ceiling tile with Large fissures and pinholes (Loc. Classroom - 102) Construction - 1951	Grey, ceiling tile	ND		75	25
S-07C	A132317-27	CT-02 – 2'x4' Ceiling tile with Large fissures and pinholes (Loc. Classroom - 104) Construction - 1951	Grey, ceiling tile	ND		75	25
S-08A	A132317-28	Concrete Block Mortar (Loc. Mechanical room - 106) Construction -1958	2 Phases: a) Green, primer b) Grey, cementitious material	Chrysotile ND	1		99 100
S-08B	A132317-29	Concrete Block Mortar (Loc. Mechanical room - 106) Construction -1958	NA	NA			
S-08C	A132317-30	Concrete Block Mortar (Loc. Mechanical room - 106) Construction -1958	NA	NA			
S-09A	A132317-31	Cellulose pipe insulation (Loc. Mechanical room - 106) Construction -1958	2 Phases: a) Brown, compressed fibrous material b) Black, fibrous material with tar	ND Chrysotile	 80	90 10	10 10
S-09B	A132317-32	Cellulose pipe insulation (Loc. Mechanical room - 106) Construction -1958	NA	NA			
S-09C	A132317-33	Cellulose pipe insulation (Loc. Mechanical room - 106)	NA	NA			

EMC LAB REPORT NUMBER: A132317

Client's Job/Project Name/No.: 23079-01

Analyst: Elizabeth Mierzynski

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)			
				Asbestos Fibres		Non-asbestos Fibres	Non-fibrous Material
		Construction -1958					
S-10A	A132317-34	Parging Cement on pipe fittings (Loc. Mechanical room - 106) Construction -1958	Grey, parging cement	Chrysotile	80		20
S-10B	A132317-35	Parging Cement on pipe fittings (Loc. Mechanical room - 106) Construction -1958	NA	NA			
S-10C	A132317-36	Parging Cement on pipe fittings (Loc. Mechanical room - 106) Construction -1958	NA	NA			
S-11A	A132317-37	Ceramic Block Mortar (Loc. Corridor - 149) Construction -1958	White and grey, cementitious material	ND			100
S-11B	A132317-38	Ceramic Block Mortar (Loc. Corridor - 149) Construction -1958	White and grey, cementitious material	ND			100
S-11C	A132317-39	Ceramic Block Mortar (Loc. Corridor - 149) Construction -1958	White and grey, cementitious material	ND			100
S-12A	A132317-40	Drywall Joint Compound on Wall (Loc. Classroom - 105) Construction -1958	White, joint compound	ND			100
S-12B	A132317-41	Drywall Joint Compound on Wall (Loc. Classroom - 105) Construction -1958	White, joint compound	ND			100
S-12C	A132317-42	Drywall Joint Compound on Wall (Loc. Classroom - 107) Construction -1958	White, joint compound	ND			100

EMC LAB REPORT NUMBER: A132317

Client's Job/Project Name/No.: 23079-01

Analyst: Elizabeth Mierzynski

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)			
				Asbestos Fibres		Non-asbestos Fibres	Non-fibrous Material
S-13A	A132317-43	Drywall Joint Compound on Wall (Loc. Classroom - 310) Construction -1967	White and off white, joint compound	ND			100
S-13B	A132317-44	Drywall Joint Compound on Wall (Loc. Classroom - 310 office) Construction -1967	White, joint compound	ND			100
S-13C	A132317-45	Drywall Joint Compound on Wall (Loc. Classroom - 312) Construction -1967	White, joint compound	ND			100
S-13D	A132317-46	Drywall Joint Compound on Wall (Loc. Classroom - 314) Construction -1967	White, joint compound	ND			100
S-13E	A132317-47	Drywall Joint Compound on Wall (Loc. Classroom - 309) Construction -1967	White, joint compound	ND			100
S-13F	A132317-48	Drywall Joint Compound on Wall (Loc. Classroom - 305B) Construction -1967	White, joint compound	ND			100
S-13G	A132317-49	Drywall Joint Compound on Wall (Loc. Classroom - 305) Construction -1967	White, joint compound	ND			100
S-14A	A132317-50	Brick Mortar (Loc. Corridor - 360) Construction -1967	2 Phases: a) Off white and grey, primer b) Grey, off white and grey, cementitious material	Chrysotile Chrysotile	0.5 <0.5		99.5 100
S-14B	A132317-51	Brick Mortar (Loc. Corridor - 360)	NA	NA			

EMC LAB REPORT NUMBER: A132317

Client's Job/Project Name/No.: 23079-01

Analyst: Elizabeth Mierzynski

Client's Sample ID	Lab Sample No.	Description/Location	Sample Appearance	SAMPLE COMPONENTS (%)			
				Asbestos Fibres		Non-asbestos Fibres	Non-fibrous Material
		Construction -1967					
S-14C	A132317-52	Brick Mortar (Loc. Corridor - 360) Construction -1967	NA	NA			
S-15A	A132317-53	CT-03 - 1'x1' Ceiling tile with Large fissures and pinholes (Loc. Classroom - 314) Construction - 1967	Grey, ceiling tile	ND		75	25
S-15B	A132317-54	CT-03 - 1'x1' Ceiling tile with Large fissures and pinholes (Loc. Classroom - 315) Construction - 1967	Grey, ceiling tile	ND		75	25
S-15C	A132317-55	CT-03 - 1'x1' Ceiling tile with Large fissures and pinholes (Loc. Classroom - 316) Construction - 1967	Grey, ceiling tile	ND		75	25

Note:

1. Bulk samples are analyzed using Polarized Light Microscopy (PLM) and dispersion staining techniques. The analytical procedures are in accordance with EPA 600/R-93/116 method.
2. The results are only related to the samples analyzed. **ND** = None Detected (no asbestos fibres were observed), **NA** = Not Analyzed (analysis stopped due to a previous positive result).
3. This report may not be reproduced, except in full without the written approval of EMC Scientific Inc. This report may not be used by the client to claim product endorsement by NVLAP or any other agency of the U.S. Government.
4. The Ontario Regulatory Threshold for asbestos is 0.5%. The limit of quantification (LOQ) is 0.5%.
5. Vermiculite is present but is too small to analyze.
6. Vermiculite is present.

APPENDIX II
LABORATORY ANALYSIS REPORT – LEAD

**EMSL Canada Inc.**

2756 Slough Street, Mississauga, ON L4T 1G3

Phone/Fax: (289) 997-4602 / (289) 997-4607

<http://www.EMSL.com>torontolab@emsl.com

EMSL Canada Or 552605656

CustomerID: 55MAPL78

CustomerPO: 23079-01

ProjectID:

Attn: **Nirmal Soni**
Maple Environmental, Inc.
482 South Service Road East
Suite 116
Oakville, ON L6J 2X6

Phone: (905) 257-4408
Fax: (905) 257-8865
Received: 3/20/2026 02:24 PM
Collected: 3/19/2026

Project: **23079-01/ DDSB Brock HS, HVAC upgrades, Dsub****Test Report: Lead in Paint Chips by Flame AAS (SW 846 3050B/7000B)***

<i>Client Sample</i>	<i>Description</i>	<i>Collected</i>	<i>Analyzed</i>	<i>Weight</i>	<i>RDL</i>	<i>Lead Concentration</i>
Pb-01 552605656-0001		3/19/2026	3/23/2026	0.2533 g	0.0064 % wt	0.070 % wt
	Site: Beige Paint on Concrete Block wall (Loc. Classroom - 102)					
Pb-03 552605656-0003		3/19/2026	3/23/2026	0.2566 g	0.0064 % wt	<0.0064 % wt
	Site: White Paint on Drywall (Loc. Classroom - 105)					
Pb-04 552605656-0004		3/19/2026	3/23/2026	0.2556 g	0.0064 % wt	<0.0064 % wt
	Site: Grey paint on Drywall (Loc. Classroom - 105)					
Pb-06 552605656-0006		3/19/2026	3/23/2026	0.2590 g	0.0064 % wt	0.010 % wt
	Site: Light Pink Paint on Masonry wall (Loc. Classroom 311)					
Pb-08 552605656-0008		3/19/2026	3/23/2026	0.2525 g	0.0064 % wt	<0.0064 % wt
	Site: Black Paint on Masonry Wall (Loc. Automotive - 300)					
Pb-09 552605656-0009		3/19/2026	3/23/2026	0.2582 g	0.0064 % wt	0.017 % wt
	Site: Orange Paint on Masonry Wall (Loc. Store room - 357)					

Rowena Fanto, Lead Supervisor
or other approved signatory

EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This report relates only to the samples reported above, and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. Results are generated from the field sampling data (sampling volumes and areas, locations, etc.) provided by the client on the Chain of Custody. Samples are within quality control criteria and met method specifications unless otherwise noted. * Analysis following Lead in Paint by EMSL SOP/Determination of Environmental Lead by FLAA. Reporting limit is 0.0064% wt based on the minimum sample weight per our SOP. "<" (less than) result signifies the analyte was not detected at or above the reporting limit. Measurement of uncertainty is available upon request. Definitions of modifications are available upon request.

Samples analyzed by EMSL Canada Inc. Mississauga, ON AIHA LAP, LLC-ELLAP Accredited #196142

Initial report from 03/27/2026 10:48:37

**EMSL Canada Inc.**

2756 Slough Street, Mississauga, ON L4T 1G3

Phone/Fax: (289) 997-4602 / (289) 997-4607

<http://www.EMSL.com>torontolab@emsl.com

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CustomerID: 55MAPL78

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Phone: (905) 257-4408
Fax: (905) 257-8865
Received: 3/20/2026 02:24 PM
Collected: 3/19/2026

Project: **23079-01/ DDSB Brock HS, HVAC upgrades, Dsub****Test Report: Lead by Flame AAS (SW 846 3050B/7000B)***

<i>Client SampleDescription</i>	<i>Collected</i>	<i>Analyzed</i>	<i>Weight (g)</i>	<i>RDL</i>	<i>Lead Concentration</i>
Pb-02 552605656-0002	3/19/2026	3/25/2026 Site: Concrete Block Mortar (Loc. Classroom - 104)	0.5047 g	32 mg/Kg	68 mg/Kg
Pb-05 552605656-0005	3/19/2026	3/25/2026 Site: Ceramic block mortar (Loc. Corridor - 149)	0.5001 g	32 mg/Kg	<32 mg/Kg
Pb-07 552605656-0007	3/19/2026	3/25/2026 Site: Brick Mortar (Loc. Corridor 360) Insufficient sample to reach reporting limit	0.1219 g	130 mg/Kg	<130 mg/Kg

Rowena Fanto, Lead Supervisor
or other approved signatory

EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This report relates only to the samples reported above, and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. Results are generated from the field sampling data (sampling volumes and areas, locations, etc.) provided by the client on the Chain of Custody. Samples are within quality control criteria and met method specifications unless otherwise noted.

* Analysis following Lead in Soil/Solids by EMSL SOP/Determination of Environmental Lead by FLAA. Reporting limit is 40 mg/kg based on the minimum sample weight per our SOP. Unless noted, results in this report are not blank corrected. "<" (less than) result signifies that the analyte was not detected at or above the reporting limit. Measurement of uncertainty is available upon request. Definitions of modifications are available upon request.

Samples analyzed by EMSL Canada Inc. Mississauga, ON

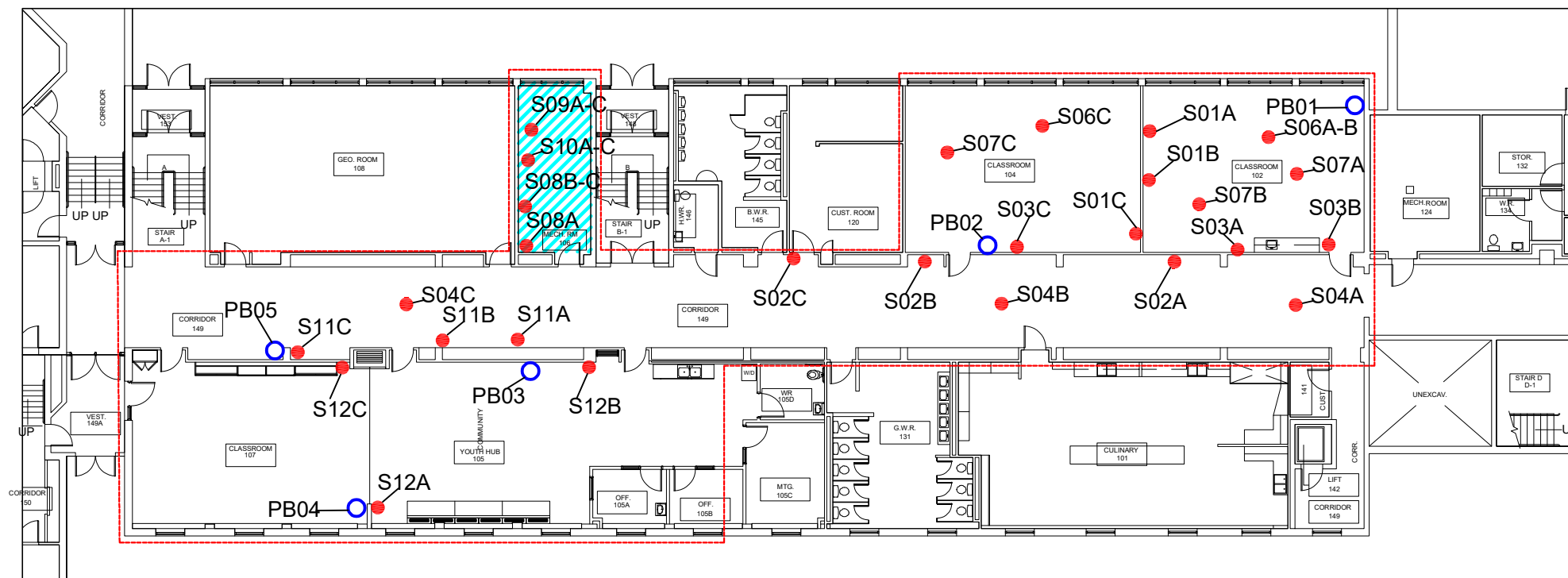
Initial report from 03/27/2026 10:48:37

APPENDIX III

DRAWINGS

NOTE:

1. ASBESTOS-CONTAINING MASONRY PRIMER IS PRESENT WITHIN THE MECHANICAL ROOM 106.
2. ASBESTOS-CONTAINING DRYWALL JOINT COMPOUND ON WALL IS PRESENT WITHIN CLASSROOM (102 AND 104).



PROJECT NO.:

23079-1

Drawn By:

N. Soni

Checked By:

K. Prosser

SAMPLE LOCATIONS

SYMBOL	DESCRIPTION
	ASBESTOS BULK SAMPLE: S##
	LEAD BULK SAMPLE: PB##
	SURVEYED AREA

CONFIRMED & SUSPECTED ACM

SYMBOL	DESCRIPTION
	MECHANICAL INSULATIONS

Designated Substance Survey

Durham District School Board

Brock High School
North Classroom Wing

First Floor Plan

SCALE

NTS

SHEET

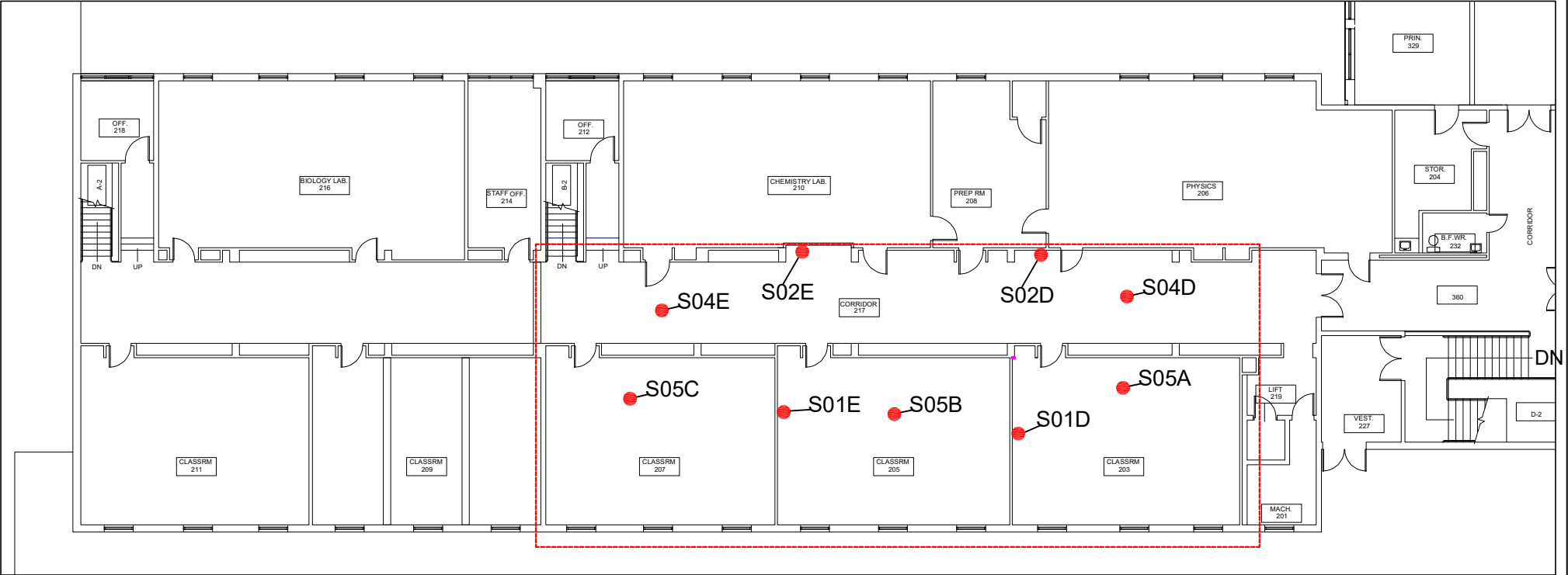
DS-01

DATE:

April, 2026



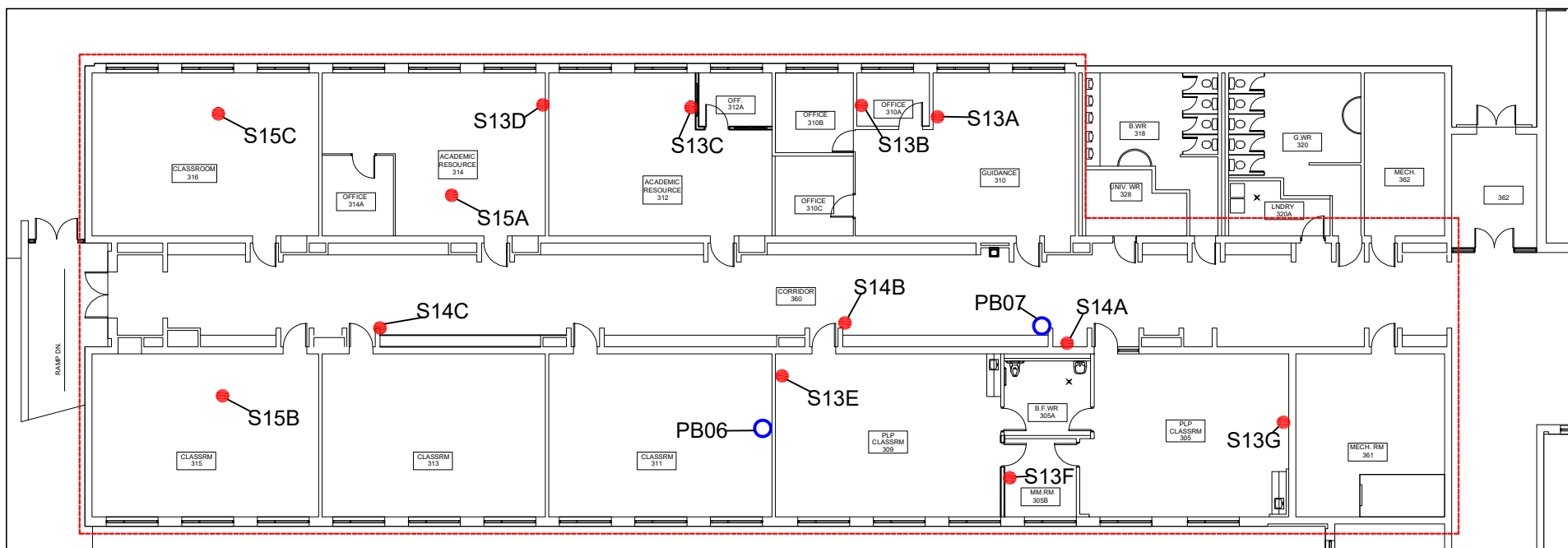
NOTE:
1. ASBESTOS-CONTAINING DRYWALL JOINT COMPOUND ON WALL IS PRESENT WITHIN CLASSROOM (203, 205 AND 207).



SAMPLE LOCATIONS	
SYMBOL	DESCRIPTION
	ASBESTOS BULK SAMPLE: S##
	LEAD BULK SAMPLE: PB##
	SURVEYED AREA

CONFIRMED & SUSPECTED ACM	
SYMBOL	DESCRIPTION
	NOTE MECHANICAL INSULATIONS

Designated Substance Survey
Durham District School Board
Brock High School
North Classroom Wing
Second Floor Plan



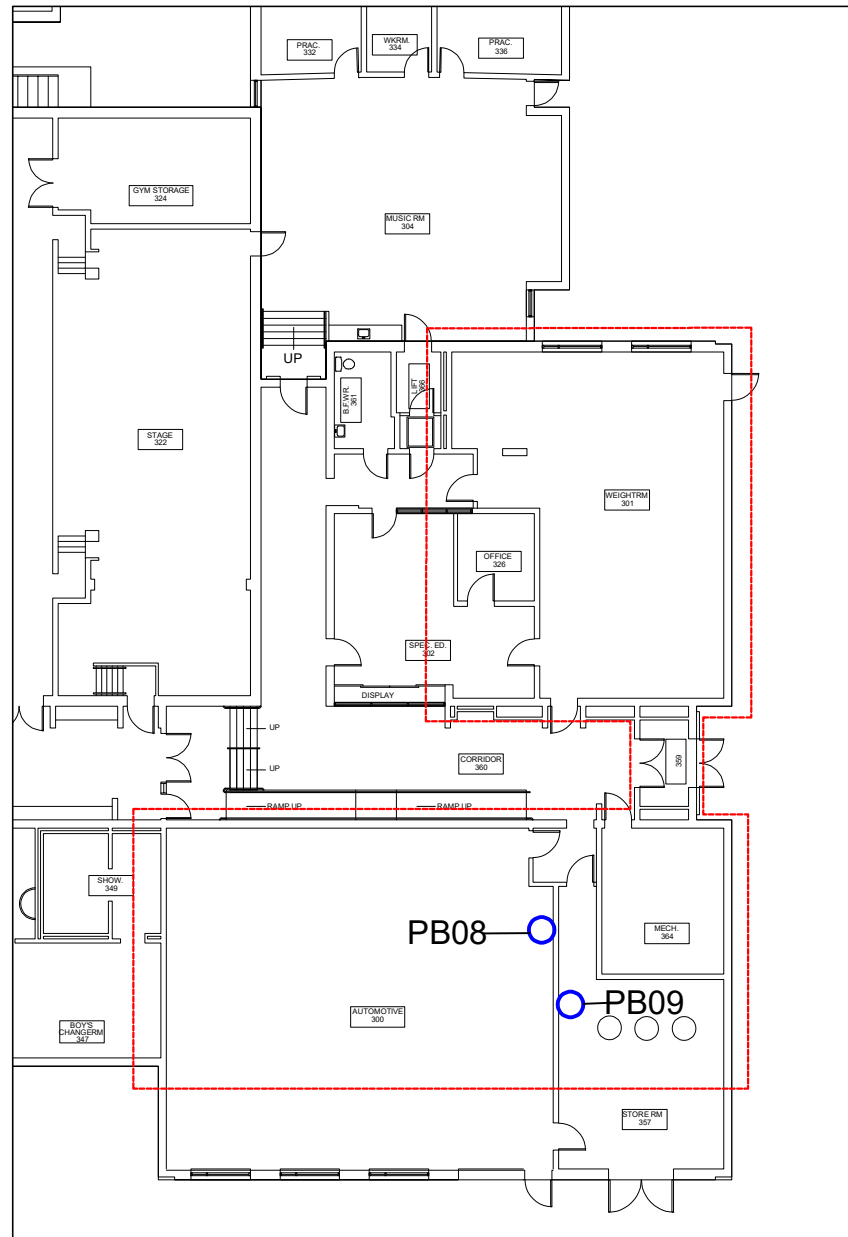
PROJECT NO.:
23079-1
 Drawn By:
N. Soni
 Checked By:
K. Prosser

SAMPLE LOCATIONS	
SYMBOL	DESCRIPTION
	ASBESTOS BULK SAMPLE: S##
	LEAD BULK SAMPLE: PB##
	SURVEYED AREA

CONFIRMED & SUSPECTED ACM	
SYMBOL	DESCRIPTION
	NOTE MECHANICAL INSULATIONS

Designated Substance Survey
 Durham District School Board
 Brock High School
 South Classroom Wing
 Second Floor Plan

SCALE	
NTS	
SHEET	
DS-01	
DATE:	April, 2026



PROJECT NO.:
23079-1
 Drawn By:
N. Soni
 Checked By:
K. Prosser

SAMPLE LOCATIONS		CONFIRMED & SUSPECTED ACM	
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	ASBESTOS BULK SAMPLE: S##		NOTE MECHANICAL INSULATIONS
	LEAD BULK SAMPLE: PB##		
	SURVEYED AREA		

Designated Substance Survey
 Durham District School Board
 Brock High School
 Automotive Wing
 Second Floor Plan

SCALE	
NTS	
SHEET	
DS-01	
DATE:	April, 2026

MECHANICAL SPECIFICATIONS

DDSB Brock High School Renovations

DURHAM REGIONAL ROAD 12, CANNINGTON, ON

DDSB Tender #: T26-32

Project #: 25184

Revision 00

April 28, 2026



RDZ ENGINEERS LIMITED

17A - 30 Pennsylvania Avenue
Vaughan, Ontario
L4K 4A5

April 28, 2026	0	ISSUED FOR PERMIT & TENDER	MH	GR
Date	Revision	Description	Prep. By	Check By

DIVISION 20

MECHANICAL COMMON WORK RESULTS

Section 20 05 05	Mechanical Work General Instructions
Section 20 05 10	Basic Mechanical Materials and Methods
Section 20 05 15	Seismic Control and Restraint
Section 20 05 20	Mechanical Vibration Isolation
Section 20 05 25	Mechanical Insulation
Section 20 05 30	Variable Frequency Drives
Section 20 05 35	Demolition and Revision Work
Section 20 05 40	Mechanical Work Commissioning
Section 20 05 50	Testing, Adjusting and Balancing
Section 20 05 55	Firestopping and Smoke Seal Systems

DIVISION 22

PLUMBING

Section 22 11 00	Domestic Water Piping and Specialties
Section 22 13 00	Drainage and Vent Piping and Specialties
Section 22 42 00	Plumbing Fixtures and Fittings
Section 22 70 05	Vehicle Service Piping
Section 22 70 10	Garage Compressed Air System

DIVISION 23

HEATING, VENTILATING AND AIR CONDITIONING

Section 23 09 30	Refrigerant Detection Systems
Section 23 11 23	Natural Gas Piping System
Section 23 20 00	Hydronic Piping Specialties and Pumps
Section 23 23 00	Refrigerant Piping, Valves and Accessories
Section 23 25 00	HVAC Water Treatment
Section 23 30 00	HVAC Air Distribution
Section 23 33 05	Silencers
Section 23 33 65	Energy Recovery Ventilators
Section 23 34 00	HVAC Fans
Section 23 62 13	Air-Cooled Heat Pump Condensing Units
Section 23 73 13	Semi-Custom Indoor Air Handling Units
Section 23 74 33	Semi-Custom Rooftop Units
Section 23 81 29	Variable Refrigerant Flow HVAC Systems
Section 23 82 00	Radiation Units
Section 23 82 39	Motorized Heaters

DIVISION 25

INTEGRATED AUTOMATION

Section 25 05 05

Automatic Control Systems

END OF SECTION

1. GENERAL

1.01 REFERENCES

- .1 Division 00 and Division 01 apply to and are a part of this Section.

1.02 APPLICATION

- .1 This Section specifies requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or 01 to take precedence.
- .2 Be responsible for advising product vendors of requirements of this Section.

1.03 DEFINITIONS

- .1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
- .2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
- .3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
- .4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.
- .5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify and certify.
- .6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers' assistance to Contractor.
- .7 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Owner and reviewed with Consultant.
- .8 "barrier-free" – means when applied to a building and its facilities, that building and its facilities can be approached, entered and used by persons with physical or sensory disabilities in accordance with requirements of local governing building code.
- .9 "BAS" – means building automation system; "BMS" – means building management system; "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS" and "DDC" generally mean same.
- .10 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.

- .11 "OSHA" and "OHSA" – stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.
- .12 "Mechanical Divisions" – refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
- .13 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- .14 "Consultant" – means person, firm or corporation identified as such in Agreement or Documents, and is licensed to practice in Place of the Work, and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.
- .15 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.
- .16 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.04 DOCUMENTS

- .1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.
- .2 Specification is arranged in accordance with CSI/CSC 50 Division Sections MasterFormat.
- .3 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
- .4 Review Drawings and Specifications in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.
- .5 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Mechanical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.
- .6 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.

- .7 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.
- .8 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.
- .9 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.
- .10 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical, and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .11 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by Consultant to any other party.
- .12 In the case of discrepancies between the drawings and specifications, documents will govern in order specified in "General Conditions", however, when scale and date of drawings are same, or where discrepancy exists within specification, most costly arrangement will take precedence.

1.05 METRIC AND IMPERIAL MEASUREMENTS

- .1 Generally, both metric and imperial units of measurement are given in Sections of Specification governed by this section. Measurement conversions may be generally "soft" and rounded off. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable local code requirements, and/or as applicable, make accurate measurements onsite. Where significant discrepancies are found, immediately notify Consultant for direction.

1.06 EXAMINATION OF DOCUMENTS AND SITE

- .1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work, and include for such conditions in Bid Price.
- .2 Report to Consultant, prior to Bid Submittal, any existing site condition that will or may affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.
- .3 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, immediately notify Consultant, in writing.
- .4 EDIT FOLLOWING ARTICLE TO SUIT PROJECT SCOPE OF WORK. COORDINATE WITH REQUIREMENTS SPECIFIED IN INSTRUCTIONS TO BIDDERS.

1.07 WORK STANDARDS

- .1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.
- .2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Owner and reviewed with Consultant.
- .3 Supplementary mandatory specification and requirements to be used in conjunction with project include but are not limited to following:
 - .1 Air-Conditioning, Heating and Refrigeration Institute (AHRI);
 - .2 Air Movement and Control Association (AMCA);
 - .3 American Iron and Steel Institute (AISI);
 - .4 American National Standards Institute (ANSI);
 - .5 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);
 - .6 American Society of Mechanical Engineers (ASME);
 - .7 American Society of Testing and Materials (ASTM);
 - .8 American Water Works Association (AWWA);
 - .9 Associated Air Balance Council (AABC);
 - .10 Building Industry Consulting Services, International (BICSI);
 - .11 Canadian Gas Association (CGA);
 - .12 Canadian General Standards Board (CGSB);
 - .13 Canadian Standards Association (CSA);
 - .14 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
 - .15 Electrical Safety Authority (ESA);
 - .16 Electronic Industries Association (EIA);
 - .17 Factory Mutual Systems (FM);
 - .18 Illuminating Engineering Society (IES);
 - .19 Institute of Electrical and Electronic Engineers (IEEE);
 - .20 International Standards Organization (ISO);

- .21 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS);
 - .22 National Building Code of Canada (NBC);
 - .23 National Electrical Manufacturers Association (NEMA);
 - .24 National Environmental Balancing Bureau (NEBB);
 - .25 National Fire Protection Association (NFPA);
 - .26 National Standards of Canada;
 - .27 NSF International;
 - .28 Occupational Health and Safety Act (OHSA);
 - .29 Ontario Building Code (OBC);
 - .30 Ontario Electrical Safety Code (OESC);
 - .31 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);
 - .32 Technical Standards and Safety Authority (TSSA);
 - .33 Thermal Insulation Association of Canada (TIAC);
 - .34 Underwriters' Laboratories of Canada (ULC);
 - .35 Workplace Hazardous Materials Information System (WHMIS);
 - .36 Material Safety Data Sheets by product manufacturers;
 - .37 local utility inspection permits;
 - .38 Codes, standards, and regulations of local governing authorities having jurisdiction;
 - .39 additional codes and standards listed in Trade Sections;
 - .40 Owner's standards.
- .4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.
 - .5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.
 - .6 Unless otherwise specified, install equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions. Notify Consultant in writing of conflicts between Contract Documents and manufacturer's instructions.

- .7 Work is to be performed by journeyperson tradesmen who perform only work that their certificates permit, or by apprentice tradesmen under direct on site supervision of experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined by the Board as stated in Ontario College of Trades and Apprenticeship Act or local equivalent governing body in Place of the Work.
 - .8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review with Consultant at any time.
 - .9 Experienced and qualified superintendent is to be on-site at times when work is being performed.
 - .10 Protect existing areas above, below and adjacent areas of Work from any debris, noise, or interruptions to existing services to satisfaction of Owner and reviewed with Consultant. Maintain in operation existing services to these areas to allow Owner to continue use of these areas. If services that are required to be maintained run through areas of renovations, provide necessary protection to services or reroute, in coordination with Owner and Consultant. Include for required premium time work to meet these requirements.
 - .11 Work being performed within occupied spaces and work affecting surfaces adjacent to occupied spaces may need to be performed after regular business hours. For areas where spaces are used by Owner on a 24 hours basis or over various hours, coordinate hours of work with Owner on a regular basis to suit Owner's schedule. Execute work at times confirmed with and agreed to by Owner and reviewed with Consultant, so as not to inconvenience Owner's occupation or in any way hinder Owner's use of building. Include for required premium time work to meet these requirements.
 - .12 Coordinate work inspection reviews and approvals with governing inspection department to ensure construction schedule is not delayed. Be responsible for prompt notification of deficiencies to Consultant and submission of reports and certificates to Consultant.
 - .13 Properly protect equipment and materials on site from damage and defacement due to elements and work of trades, to satisfaction of Owner and reviewed with Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.
 - .14 Mechanical piping system work, including equipment, must comply in all respects with requirements of local technical standards authorities and CSA B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, mechanical work products are to bear a CRN number.
 - .15 Electrical items associated with mechanical equipment are to be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.
- 1.08 PERMITS, CERTIFICATES, APPROVALS AND FEES
- .1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities. Obtain and pay for permits, certificates, and approvals required to complete Work.

- .2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work. If any defect, deficiency or non-compliant is found in work by inspection, be responsible for costs of such inspection, including any related expenses, making good and return to site, until work is passed by governing authorities.
- .3 Obtain and submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities and are acceptable.
- .4 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.

1.09 REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

- .1 Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
- .2 Retained engineer's professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regards to the Work of this Contract.
- .3 Unless otherwise specified in Division 00 or 01, liability insurance requirements are as follows:
 - .1 coverage is to be a minimum of \$1,000,000.00 CDN inclusive of any one occurrence;
 - .2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;
 - .3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work;
 - .4 retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above;
 - .5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.

1.10 WORKPLACE SAFETY

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.

- .2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.
- .3 If at any time during course of existing building work, hazardous materials other than those identified in Documents and pertaining to Project Scope of Work, are encountered or suspected that were not identified as being present and which specific instructions in handling of such materials were not given, cease work in area in question and immediately notify Consultant. Comply with local governing regulations with regards to working in areas suspected of containing hazardous materials. Do not resume work in affected area without approval from Owner and reviewed with Consultant.

1.11 PLANNING AND LAYOUT OF WORK

- .1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:
 - .1 piping requiring uniform pitch;
 - .2 piping 100 mm (4") dia. and larger;
 - .3 large ducts (main runs);
 - .4 cable tray and bus duct;
 - .5 conduit 100 mm (4") dia. and larger;
 - .6 piping less than 100 mm (4") dia.;
 - .7 smaller branch ductwork;
 - .8 conduit less than 100 mm (4") dia..
- .3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.
- .4 Do not use Contract Drawing measurements for prefabrication and layout of piping, sheet metal work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.

- .5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or $\frac{1}{4}"=1' 0"$) of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.
 - .6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
 - .7 Shut-off valves, balancing devices, air vents, equipment and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
 - .8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.
- 1.12 PHASING
- .1 USE FOLLOWING PARAGRAPH FOR GENERAL PHASING REQUIREMENTS ON NEW CONSTRUCTION WHERE IT HAS BEEN CONFIRMED THAT REQUIREMENTS ARE IN DIVISION 01 OR ON DRAWINGS.
 - .2 Include for scheduling, coordination, and construction phasing to suit project. Review exact phasing requirements with Consultant and Owner prior to start of Work.
 - .3 Phasing and scheduling of Work is required in order to maintain existing building operations. Include costs (including costs for "off hours" work) for scheduling, coordination, and construction phasing to suit this project. Review phasing requirements with Consultant prior to start of Work.
 - .4 Provide for each partial permit, required local governing authority certificate and any other testing/verification certificates for systems where required.
- 1.13 COORDINATION OF WORK
- .1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include but not be limited to following:
 - .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;
 - .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;

- .3 depth and routing of excavation required for work, and requirements for bedding and backfill;
- .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.
- .2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.
- .3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building, subject to available space as confirmed with Owner and reviewed with Owner, and protected from elements.
- .4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.
- .5 Where work is to be integrated, or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

1.14 PRODUCTS

- .1 Be responsible for ordering of products (equipment and materials) in a timely manner in order to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.
- .2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new and are to comply with applicable respective Canadian standards. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada (ULC) listed for use in Canada. Products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards, as applicable. Do not supply any products containing asbestos materials or PCB materials.
- .3 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for an extended period of time will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.

- .4 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any product specified by manufacturer's name and model number. Where acceptable manufacturers are listed, first name listed is base specified company. Bid Price may be based on products supplied by any of manufacturers' base specified or named as acceptable for particular product. If acceptable manufacturers are not stated for a particular product, base Bid Price on product supplied by base specified manufacturer.
- .5 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by Consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.
- .6 Listing of a product as "acceptable" does not imply automatic acceptance by Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received and submittals made are for products that meet or exceed specifications included herein.
- .7 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.
- .8 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product. Indicate any proposed substitutions in areas provided on Bid Form. Do not order such products until they are accepted in writing by Consultant.

- .9 Indicate in Supplementary Mechanical Bid Form, names of manufacturers for proposed products to be supplied, and which were based specified or scheduled with a manufacturer's name. Names of proposed manufacturers on list must be one of names stated as acceptable for particular products, unless prior approval from Owner has been given for use of products by other manufacturers. Submit to Consultant for review as directed.
 - .10 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.
 - .11 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance characteristics) are submitted to Consultant for review. Failure of submission of these documents to Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.
 - .12 Products supplied by a manufacturer/supplier other than a manufacturer listed as acceptable may be considered for acceptance by Consultant if requested in writing with full product documentation submitted, a minimum of 10 working days prior to Bid closing date.
 - .13 Any proposed changes initiated by Contractor after award of Contract may be considered by Consultant at Consultant's discretion, with any additional costs for such changes if accepted by Owner and reviewed with Consultant, and costs for review, to be borne by Contractor.
 - .14 Whenever use of product other than based specified products or named as acceptable is being supplied, time for process of submission of other products and Consultant's review of products will not alter contract time or delay work schedule.
 - .15 DELETE FOLLOWING ARTICLE EXCEPT FOR BC OFFICE PROJECTS THIS ARTICLE IS OPTIONALLY IN LIEU OF PRECEDING ARTICLE. ENSURE THAT ONE IS DELETED.
- 1.15 SHOP DRAWINGS
- .1 At start-up meeting, review with Consultant products to be included in shop drawing submission. Prepare and submit list of products to Consultant for review.
 - .2 Submit electronic copies of shop drawings unless otherwise directed by Consultant. Coordinate exact requirements with Consultant.
 - .3 Submit for review, drawings showing detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to Consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:

- .1 product literature cuts;
 - .2 equipment data sheets;
 - .3 equipment dimension drawings;
 - .4 system block diagrams;
 - .5 sequence of operation;
 - .6 connection wiring schematic diagrams;
 - .7 functionality with integrated systems.
- .4 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
- .5 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.
- .6 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted.
- .7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:
- .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;
 - .2 "RETURNED FOR CORRECTION" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.
- .8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each and every shop drawing or product data sheet submitted:
- "THIS REVIEW BY CONSULTANT IS FOR SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAILED DESIGN INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR. CONSULTANT'S REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR COORDINATION OF WORK OF SUB-TRADES."

- .9 Submit each system and each major component as separate shop drawing submissions. Submit together, shop drawings for common devices such as devices of each system are to be submitted together.
- .10 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.
- .11 Do not order product until respective shop drawing review process has been properly reviewed with Consultant.
- .12 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.
- .13 Applicable mechanical equipment has been selected to meet energy efficiency requirements of ANSI/ASHRAE/IES 90.1, Energy Standards for Buildings, and shop drawings/product data submittals for such equipment are to indicate compliance with this Standard or they will be returned for correction and re-submittal.

1.16 ENGINEERED SUBMITTALS

- .1 Submittals for items required to be sealed by a professional engineer (engineered) are to be duly prepared, sealed, and signed under direct control and supervision of a qualified professional engineer licensed in jurisdiction of the work. Professional engineer is to conform to requirements specified in this Section in article entitled Requirements for Contractor Retained Engineers.
- .2 Engineered submittals are to include, but not be limited to, following:
 - .1 complete CAD layout drawings indicating equipment, piping schematic, pipe routing and sizing, zones, devices, wiring schematics, and any other pertinent data;
 - .2 listing of design data used to determine system layout and sizing;
 - .3 complete copies of design calculations and listing of design data used in preparing calculations;
 - .4 list detailing standards, codes, regulations, etc. adhered to when designing system;
 - .5 items as noted in other Sections of the Specification.
- .3 Professional engineer responsible for engineered submittals is to perform periodic field reviews, including review of associated mock-ups where applicable, at locations wherever work as described by engineered submittal is in progress, during fabrication and installation of such work, and submit a field review report after each visit. Submit field review reports to Consultant and authorities having jurisdiction as required.
- .4 Field reviews are to be at intervals as necessary and appropriate to progress of work described by engineered submittal to allow engineer to be familiar with progress and quality of such work and to determine if work is proceeding in general conformity with Contract Documents including reviewed shop drawings and design calculations.

- .5 Upon completion of work as described by engineered submittal, professional engineer responsible for preparation of engineered submittal and for performing periodic field reviews is to prepare and submit to Consultant and, if applicable, authorities having jurisdiction, a letter certifying that work has been supplied and installed in accordance with requirements of Contract Documents, authorities having jurisdiction and engineered submittal.
- 1.17 EQUIPMENT LOADS
- .1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to Consultant, via shop drawing submissions, prior to construction.
 - .2 Where given choice of specific equipment, actual weight, location and method of support of equipment may differ from those assumed by Consultant for base design. Back-check equipment loads, location, and supports, and include necessary accommodations.
 - .3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Review locations of equipment with Consultant prior to construction.
- 1.18 OPENINGS
- .1 Supply opening sizes and locations to Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
 - .2 No openings are permitted through completed structure without written approval from Owner and reviewed with Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to Consultant for review, well in advance of doing work.
 - .3 Prior to leaving site at end of each day, walk through areas of work and check for any openings, penetrations, holes, and/or voids created under scope of work of project, and ensure that any openings created under scope of work have been closed off, fire-stopped and smoke-sealed. Unless otherwise directed by Owner and reviewed with Consultant, do not leave any openings unprotected and unfinished overnight.
- 1.19 SCAFFOLDING, HOISTING AND RIGGING
- .1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner and reviewed with Consultant.
 - .2 Use scaffolds in such a manner as to interfere as little as possible with work of other trades.
 - .3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Owner and reviewed with Consultant. No supports, clips, brackets or similar devices are to be welded, bolted or otherwise affixed to any finished member or surface without approval from Owner and review with Consultant.
 - .4 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.
- 1.20 CHANGES IN THE WORK

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity or type of work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation detailing proposed cost for executing change or revision.
- .2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 If overhead and profit percentages are not specified in Division 00 or 01, but allowable under Contract as reviewed with Consultant prior to contract signing, then allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.
- .4 Unless otherwise specified in Divisions 00 or 01, following additional requirements apply to all quotations submitted:
 - .1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;
 - .2 material costs are not to exceed those published in local estimating price guides;
 - .3 mechanical material labour unit costs are to be in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%;
 - .4 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at difficult level, less 25%;
 - .5 costs for journeyperson and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;
 - .6 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;
 - .7 costs for rental tools and/or equipment are not to exceed local rental costs;
 - .8 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;
 - .9 quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.
- .6 Make requests for changes or revisions to work in writing to Consultant and, if accepted by Owner, Notice of Change to be issued.
- .7 Do not execute any change or revision until written authorization for the change or revision has been obtained from Consultant.

1.21 PROGRESS PAYMENT BREAKDOWN

- .1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.
- .2 Payment breakdown is subject to Owner's approval and Consultant's review. Progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including testing, adjusting and balancing, system testing and verification, and project closeout submittals.
- .3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.

1.22 NOTICE FOR REQUIRED FIELD REVIEWS

- .1 Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to Consultant.
- .2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.23 PRELIMINARY TESTING

- .1 When directed by Consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.
- .2 When, in Consultant's opinion, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.
- .3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.
- .4 When, in Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.

1.24 PROVISIONS FOR SYSTEMS/EQUIPMENT USED DURING CONSTRUCTION

- .1 Permanent building mechanical systems are not to be used for temporary heating or cooling purposes during construction.
- .2 Confirm with Consultant what equipment can be used during construction.

- .3 Any system or piece of equipment that is specified to be provided under requirements of Documents and is required to be used during construction stages of work prior to issuing of Certificate of Substantial Performance of the Work, are to be provided with special interim maintenance and service to cover systems/equipment during time of use during construction period of project until project has been certified as substantially performed and such systems/equipment are turned over to Owner.
 - .4 During this period of construction, such systems/equipment to not become property of Owner or be Owner's responsibility for maintenance or service. Systems/equipment are to remain property of respective manufacturers/suppliers or Contractor, who are responsible for full maintenance and servicing of systems/equipment in order to maintain validity of warranties after turn over to Owner.
 - .5 Prior to application for a Certificate of Substantial Performance of the Work and turn over to Owner, such systems/equipment to be cleaned, restored to "new" condition, paint finishes "touched-up", filters cleaned or replaced, etc.
- 1.25 TEMPORARY SERVICES
- .1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to temporary heating, cooling and water. Unless otherwise noted, provide required services in compliance with requirements of local governing building code and local governing inspection authorities.
 - .2 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of local governing code and local governing authorities.
- 1.26 MAINTAINING EQUIPMENT PRIOR TO ACCEPTANCE
- .1 Maintain equipment in accordance with manufacturer's instructions prior to start-up, testing and commissioning.
 - .2 Employ a qualified millwright to check and align shafts, drives, and couplings on all base mounted split coupled motor driven equipment.
 - .3 Where equipment lubrication fittings are not easily accessible, extend the fittings to accessible locations using copper or aluminium tubing.
 - .4 All filters are to be new upon Substantial Performance of the Work. This is in addition to any spare filters specified.
- 1.27 CLEANING
- .1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Owner and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.
 - .2 Clean equipment and devices installed as part of this project.
- 1.28 RECORD AS-BUILT DRAWINGS

- .1 Drawings for this project have been prepared on a CAD system using AutoCAD software of release version reviewed with Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from Consultant, at expense of \$500.00 CDN plus HST, per drawing, up to first 5 drawings, and \$100.00 CDN plus HST, per any additional drawings thereafter. Drawings may also to be used for preparation of layouts and interference drawings.
- .2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes and deviations from routing of services and locations of equipment shown on Contract Drawings, on a daily basis. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date at all times, and ensure set is always available for periodic review. As-built set is also to include the following:
 - .1 dimensioned location of inaccessible concealed work;
 - .2 locations of control devices with identification for each;
 - .3 for underground piping and ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories if applicable, and locate dimensions from benchmarks to be preserved after construction is complete;
 - .4 for fire protection systems, record actual locations of equipment, sprinkler heads, and valves, drains, and test locations, and deviations of pipe routing and sizing from that shown on the drawings;
 - .5 location of piping system air vents;
 - .6 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
- .3 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of Consultant.
- .4 Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant.
- .5 Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with AutoCAD software release version confirmed with Consultant.
- .6 Unless otherwise noted in Divisions 00 or 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Owner and reviewed with Consultant.

1.29 OPERATING AND MAINTENANCE MANUALS

- .1 For each item of equipment for which a shop drawing is required (except for simple equipment), supply minimum 3, project specific, indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Review exact quantity of manuals with Consultant. Consolidate each copy of data in an identified hard cover three "D" ring binder. Each binder to include:
 - .1 front cover: project name; wording – "Mechanical Systems Operating and Maintenance Manual"; and date;
 - .2 introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;
 - .3 equipment manufacturer's authorized contact person name, telephone number and company website;
 - .4 Table of Contents sheet, and corresponding index tab sheets;
 - .5 copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "Reviewed As Noted" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "Reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;
 - .6 operating data as follows:
 - .1 pressure test reports, and certificates issued by governing authorities;
 - .2 description of each system and its controls;
 - .3 control schematics for equipment/systems including building environmental controls;
 - .4 wiring and connection diagrams;
 - .5 if applicable, BAS architecture and all required operating data;
 - .6 description of operation of each system at various loads together with reset schedules and seasonal variances;
 - .7 operation instruction for each system and each component;
 - .8 description of actions to be taken in event of emergencies and/or equipment failure;
 - .9 valve tag schedule, and flow diagrams to indicate valve locations.
 - .7 maintenance data as follows:
 - .1 operation and trouble-shooting instructions for each item of equipment and each system;
 - .2 schedules of tasks, frequency, tools required, and estimated task time;

- .3 recommended maintenance practices and precautions including warnings of any maintenance practice that will damage or disfigure equipment/systems;
 - .4 complete parts lists with numbers.
 - .8 performance data as follows:
 - .1 equipment and system start-up data sheets;
 - .2 equipment performance verification test results, and final commissioning report;
 - .3 final testing, adjusting and balancing reports.
 - .9 copies of warranties;
 - .10 items requested specifically in Section Articles.
 - .2 Generally, binders are not to exceed 75 mm (3") thick and not to be more than 2/3 full.
 - .3 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner's building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.
 - .4 Before applying for a Certificate of Substantial Performance of the Work, assemble one copy of O & M Manual and submit to Consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.
 - .5 Provide 2 digital copies of contents of operating and maintenance manuals and load onto separate USB type flash drives and submit to Consultant. Prepare digital copies using version of Adobe Acrobat Portable Document Format or equal as reviewed with Consultant and enhanced with bookmarks and internal document links.
- 1.30 WARRANTY
- .1 Unless otherwise specified in Divisions 00 and 01, warrant mechanical work to be in accordance with Contract Documents and free from defects for a period of 1 year from date of issue of a Certificate of Substantial Performance of the Work.
 - .2 Where equipment includes extended warranty period, e.g., 5 years, first year of warranty period is to be governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are to be direct from equipment manufacturer and/or supplier to Owner. Submit signed and dated copies of extended warranties to Consultant.
 - .3 Warranty to include parts, labour, travel costs and living expenses incurred by manufacturer's authorized technician to provide factory authorized on-site service.
 - .4 Repair and/or replace any defects that appear in Work within warranty period without additional expense to Owner. Be responsible for costs incurred in making defective work good, including repair or replacement of building finishes, other materials, and damage to other equipment. Ordinary wear and tear and damage caused wilfully or due to carelessness of Owner's staff or agents is exempted.
 - .5 Do not include Owner deductible amounts in warranties.

- .6 Visit building during warranty period with Owner representatives. Owner to organize these visits. At these meetings, Owner representatives are to review performance of systems. If performance is satisfactory, then no further action needs to be taken. If unsatisfactory, then correct deficiencies, as directed by Owner representatives, to satisfaction of Owner's representatives. These site visits to occur:
- .7 once during 1st month of building operation;
- .8 once during 3rd month of building operation;
- .9 once between 4th and 10th month in a season opposite to 1st and 3rd month visits.

1.31 PROJECT CLOSEOUT SUBMITTALS

- .1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following:
 - .1 Operating and Maintenance Manuals;
 - .2 as-built record drawings and associated data;
 - .3 extended warranties for equipment as specified;
 - .4 operating test certificates, i.e. Sprinkler Test Certificate;
 - .5 final commissioning report and TAB report;
 - .6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;
 - .7 other data or products specified.

1.32 INSTRUCTIONS TO OWNER

- .1 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.
- .2 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel (for up to 6 people each session), on operation and maintenance procedures of system.
- .3 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals during training sessions. Training modules include but are not limited to:
 - .1 Operational Requirements and Criteria – equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations;
 - .2 Troubleshooting – diagnostic instructions, test and inspection procedures;

- .3 Documentation – equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like;
 - .4 Maintenance – inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools;
 - .5 Repairs – diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
- .4 Before instructing Owner's designated personnel, submit to Consultant for review preliminary copy of training manual and proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.
 - .5 Obtain in writing from Consultant list of Owner's representatives to receive instructions. Submit to Consultant prior to application for Certificate of Substantial Performance of the Work, complete list of systems for which instructions were given, stating for each system:
 - .1 date instructions were given to Owner's staff;
 - .2 duration of instruction;
 - .3 names of persons instructed;
 - .4 other parties present (manufacturer's representative, consultants, etc.).
 - .6 Obtain signatures of Owner's staff to verify they properly understood system installation, operation and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.
 - .7 Submit to Consultant, copy of electronic version of training materials loaded on USB flash drive. Include in operating and maintenance manuals submission.

1.33 FINAL INSPECTION

- .1 Submit to Consultant, written request for final inspection of systems. Include written certification that:
 - .1 deficiencies noted during job inspections have been completed;
 - .2 field quality control procedures have been completed;
 - .3 systems have been tested and verified, balanced and adjusted, and are ready for operation;
 - .4 maintenance and operating data have been completed and submitted to, reviewed with Consultant and accepted by Owner;
 - .5 tags and nameplates are in place and equipment identifications have been completed;
 - .6 clean-up is complete;
 - .7 spare parts and replacement parts specified have been provided and acknowledged by Consultant;

- .8 as-built and record drawings have been completed and submitted to and reviewed with Consultant and accepted by Owner;
 - .9 Owner's staff has been instructed in operation and maintenance of systems;
 - .10 commissioning procedures have been completed.
 - .2 USE FOLLOWING ARTICLE IF A PRIME COST ALLOWANCE IS REQUIRED TO BE INCLUDED IN MECHANICAL WORK COST AND ALLOWANCE IS NOT SPECIFIED IN DIVISION 01. IDEALLY, ALLOWANCE SHOULD BE SPECIFIED IN DIVISION 01 TO AVOID DOUBLE OR TRIPLE MARK-UPS, BUT IF IT HAS TO BE PART OF THE MECHANICAL WORK, EDIT THIS ARTICLE TO SUIT. COORDINATE WITH PRIME CONSULTANT AND DIVISION 00/01.
- 1.34 ALLOWANCES
- .1 Where allowances are included, amount of allowance is to be net and is to include product and material costs (less applicable trade discounts), including delivery to site and applicable taxes.
 - .2 Other costs, including unloading and handling at site, installation, overhead and profit and other burdens are to be included in Bid amount, not in allowance.
 - .3 Whenever costs are more or less than amount of allowance, Contract amount will be adjusted accordingly by Change Order.
 - .4 Materials and products under allowance will be selected by Owner in sufficient time to avoid delays to work, and Owner reserves right to take entire or any part of allowance out of Contract amount at any time.
 - .5 Expenditure from above allowances may be made only upon receipt of order signed by Consultant. Relationship of Contractor and Subcontractors performing work to be paid out of allowances to be strictly between Contractor and Contractor's Subcontractors.
- 1.35 PRODUCTS
- .1 NOT USED
- 1.36 EXECUTION
- .1 NOT USED

END OF SECTION

1. GENERAL

1.01 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Mechanical Divisions. It is intended as a supplement to each Section and is to be read accordingly.

1.02 SUBMITTALS

- .1 Submit shop drawings/product data sheets for:
 - .1 pressure gauges and thermometers;
 - .2 electric motors (submit with equipment they are associated with).
- .2 Submit weight loads for selected equipment (upon request).
- .3 Submit copy of architectural reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations.
- .4 Submit samples of materials and any other items as specified in Sections of Mechanical Divisions.
- .5 Submit a list of equipment identification nameplates indicating proposed wording and sizes.
- .6 Submit a list of pipe and duct identification colour coding and wording.
- .7 Submit a proposed valve tag chart and a list of proposed valve tag numbering and identification wording.
- .8 Submit drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.
- .9 As specified in Part 2 of this Section, submit a spare belt set, tagged and identified, for each belt driven piece of equipment.
- .10 Submit any other submittals specified in this Section or other Sections of Mechanical Divisions.

2. PRODUCTS

2.01 PIPE SLEEVES

- .1 Galvanized Sheet Steel – Minimum #16 gauge galvanized steel with an integral flange at one end to secure sleeve to formwork construction.
- .2 Polyethylene – Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.
- .3 Waterproof Galvanized Steel Pipe – Schedule 40 mild galvanized steel pipe with a welded-on square steel anchor and water stop plate at sleeve midpoint.

- .4 Galvanized Steel or Cast Iron Pipe – Schedule 40 mild galvanized steel, or Class 4000 cast iron.
- 2.02 FIRESTOPPING AND SMOKE SEAL MATERIALS
- .1 Firestopping and smoke seal system materials for mechanical penetrations through fire rated construction are specified in Section entitled Firestopping and Smoke Seal Systems and work is to be included as part of mechanical work.
- 2.03 PIPE ESCUTCHEON PLATES
- .1 One-piece chrome plated brass or #4 finish type 302 stainless steel plates with matching screws for attachment to building surface, each plate sized to completely cover pipe sleeve or building surface opening, and to fit tightly around pipe or pipe insulation.
- 2.04 PIPING HANGERS AND SUPPORTS
- .1 Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, Pipe hangers and Supports-Materials, Design and Manufacture, and where possible, MSS designations are indicated with each product specified below. Conform to following requirements:
 - .1 unless otherwise specified, ferrous hanger and support products are to be electro-galvanized;
 - .2 hangers and supports for insulated piping are to be sized to fit around insulation and insulation jacket.
 - .2 Hangers and supports for horizontal suspended piping as follows:
 - .1 adjustable steel clevis hanger – MSS Type 1;
 - .2 adjustable swivel ring band hanger – MSS Type 10;
 - .3 adjustable roller hanger – MSS Types 41, 43, and/or 45, with MSS Type 39 steel protection saddle.
 - .3 Supports for horizontal pipe on vertical surfaces as follows:
 - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
 - .2 heavy-duty steel pipe clip – MSS Type 26;
 - .3 single steel pipe hook – Myatt Fig. 156;
 - .4 epoxy coated steel pipe stays are not permitted.
 - .4 Floor supports for vertical risers as follows:
 - .1 copper tubing riser clamp – MSS Type 8;
 - .2 heavy-duty steel riser clamp – MSS Type 8.
 - .5 Supports for vertical piping on vertical surfaces as follows:

- .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
- .2 heavy-duty steel pipe bracket or soil pipe bracket – MSS Type 26;
- .3 extension split pipe clamp – MSS Type 12;
- .4 epoxy coated steel pipe stays are not permitted.
- .6 Base support for vertical risers in excess of 6 m (20') high extending out from base mounted equipment is to consist of a base elbow support with flange.
- .7 For horizontal pipe on racks, Unistrut or equal galvanized steel pipe racks with pipe securing hardware as follows:
 - .1 standard galvanized steel U-bolts/clamps supplied by rack manufacturer;
 - .2 adjustable roller chair – MSS Type 44 with MSS Type 39 steel protection saddle.
- .8 Special hangers and supports for various applications as follows:
 - .1 vibration isolated riser supports – black steel riser clamps as specified above, complete with neoprene–steel–neoprene sandwich type vibration isolation pads between clamp and floor;
 - .2 for groups of pipes having same slope – MSS Type 32 welded steel brackets, Anvil Fig. 46 universal trapeze assemblies, or Unistrut or equal support assemblies, all with U-bolts, clamps, etc., to secure pipes in place;
 - .3 for sections of piping connected to vibration isolated equipment – hangers and supports as specified above but complete with MSS Type 48 spring cushions;
 - .4 for glass drain and vent piping – special padded hangers supplied by pipe supplier;
 - .5 for plastic piping – generally as specified above but in accordance with pipe manufacturer's recommendations;
 - .6 for fire protection piping – generally as above but ULC listed and/or FM approved, and in accordance with Chapter requirements of NFPA Standard applicable to piping system;
 - .7 for bare horizontal copper piping – generally as above but factory vinyl coated to prevent direct copper/steel contact;
 - .8 for bare copper vertical piping – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate pipe from clamp;
 - .9 insulation protection shields to and including 40 mm (1-½") dia. – MSS Type 40 galvanized steel shields with ribs to keep shield centred on hanger.
- .9 Hanger rods are to be electro-galvanized carbon steel (unless otherwise specified), round, threaded, to ASTM A36, complete with captive machine nuts with washers at hangers, sized to suit loading in accordance with Table 3 in MSS SP-58, but in any case minimum 9.5 mm (3/8") diameter.
- .10 Acceptable manufacturers are:

- .11 E. Myatt & Co. Inc.;
- .12 Anvil International Inc.;
- .13 Empire Industries Inc.;
- .14 Hunt Manufacturing Ltd.;
- .15 Unistrut Canada Ltd.;
- .16 Nibco Inc. "Tolco";
- .17 Taylor Pipe Supports.

2.05 ROOF MOUNTED PIPING SUPPORTS

- .1 Portable Support System: Engineered, portable system specifically designed for installation without the need for roof penetrations or flashings, and without causing damage to the roofing membrane.
- .2 Design system using high density / high impact polypropylene bases with carbon black, anti-oxidants for UV protection, and steel framing for support is 1-5/8 inch (41 mm) B22TH or 1-7/8 inch (48 mm) BTS22TH.
- .3 Bases:
 - .1 Injection molded high density / high impact polypropylene with UV-inhibitors and anti-oxidants, conforming to the following:
 - .2 Moisture Content: Negligible.
 - .3 Shrinkage/Swelling Due to Moisture: Negligible.
 - .4 Density: 55.8 lb/cu ft (894 kg/cu m).
 - .5 Insect Resistance: No known insect damage potential.
 - .6 Chemical Resistance (oil, brake fluid, gasoline, diesel, antifreeze, battery acid, and sulfuric acid: No visual or physical change apparent.
 - .7 Flammability: No ignition after 10 minutes, 25 kW/m, when tested in accordance with ASTM D 1929.
 - .8 Sized as required by loading conditions and as indicated on the drawings.
 - .9 Shop fabricated with inserts for square tubing or threaded rods as required.
 - .10 Color: Integral black color as molded.
 - .11 Bases for Mechanical Attachment: Sealant chamber around penetration point, with injection port for sealing after fastening; beveled lip for sealant bead around entire diameter.
 - .12 Do not use bases containing carbonated plastics, press molded recycled rubber and plastics, steel, stainless steel, or any injection molded threaded receivers.

- .4 Steel Framing:
 - .1 Channel Types: 1-5/8 inch (41.3 mm) B22TH or 1-7/8 inch (47.6 mm) BTS22H, as required for loading conditions.
 - .2 Thickness: 12 gage (2.7 mm).
 - .3 Form: Roll-formed 3-sided or tubular shape, perforated with 9/16 inch (14.3 mm) holes at 1-7/8 inch (47.6 mm) centers on three sides.
 - .4 Finish: Hot dip galvanize in accordance with ASTM A 123 after fabrication, free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets, and other surface blemishes.
 - .5 Do not use tubing or tube steel.
- .5 Stainless Steel Framing:
 - .1 Channel Types: 1-5/8 inch (41.3 mm) or 1-7/8 inch (47.6 mm), as required for loading conditions.
 - .2 Thickness: 12 gage (2.7 mm).
 - .3 Form: Roll-formed 3-sided or tubular shape.
 - .4 Finish: Mill finish.
 - .5 Do not use tubing or tube steel.
- .6 Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69 and as follows:
 - .1 Fabricate of carbon steel where framing is carbon steel; fabricate of stainless steel where framing is stainless steel; finished same as framing.
 - .2 Sizes 2-1/2 inch (63 mm) and smaller: Single roller supports for piping subject to expansion and contraction; 3-sided channels and pipe clamps.
 - .3 Sizes 3 inch (76 mm) and larger: Rollers, clevis hangers, or band hangers, to allow for expansion and contraction without movement of the bases or framing.
- .7 Accessories: Clamps, bolts, nuts, washers, and other devices as required for a complete system.
 - .1 Carbon Steel: Hot-dip galvanized in accordance with ASTM A 153/A 153M.
 - .2 Stainless Steel: Mill finish.
 - .3 For Mechanical Fastening to Deck: On wood and steel decks, use bolts with toggle wings; on concrete decks use threaded rods and adhesive anchors, with rod embedded at least 1-3/4 inches (44 mm) into concrete.
- .8 Acceptable manufacturers are:
 - .1 Portable Pipe Hangers (Canada), Inc. (PHP Systems/Design);

.2 Taylor Pipe Supports (EcoFoot);

.3 Mifab, Inc.

2.06 ACCESS DOORS

- .1 Coordinate consistency of look and finish of access doors on project with each Division of Work. Coordinate exact requirements with General Trades Contractor.
- .2 Access doors to be rust resistant steel door panels, with concealed hinges and positive locking and self-opening screwdriver operated lock. Wall type frame to be suitable for wall installation and have integral keys for plaster walls. Doors in tile wall to be stainless steel and in ceilings to be suitable for plaster covering with only frame joint showing. Other doors to be prime painted steel.
- .3 Size access doors to suit the concealed work for which they are supplied, and wherever possible they are to be of standard size for all applications, but in any case they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.
- .4 Lay-in type tiles, properly marked, may serve as access panels. Coordinate marking of ceiling tiles with Consultant. Panels in glazed tile walls to be 12 gauge, 304 alloy stainless steel, No. 4 finish, with recessed frame secured with stainless steel counter-sunk flush head screws.
- .5 Panels in plaster surfaces to have dish-shaped door and welded metal lath, ready to take plaster. Provide a plastic grommet for door key access.
- .6 Other access doors to be welded 12 gauge steel, flush type with concealed hinges, lock and anchor straps, complete with factory prime coat. Submit to Consultant for review, details of non-standard door construction details.
- .7 Access doors in fire rated ceilings, walls, partitions, structures, etc., to be ULC listed and labelled and of a rating to maintain fire separation integrity.
- .8 Where access doors are located in surfaces where special finishes are required, they are to be of a recessed door type capable of accepting finish in which they are to be installed so as to maintain final building surface appearance throughout.
- .9 Acceptable manufacturers include Le Hage, SMS, Pedlar and Acudor.

2.07 PRESSURE GAUGES AND THERMOMETERS

- .1 Pressure gauges as follows:
 - .1 adjustable, glycerine filled, 100 mm or 115 mm (4" or 4-½") diameter and each accurate to within 1% of scale range;
 - .2 type 304 stainless steel case with relief valve and polished stainless steel bayonet;
 - .3 stainless steel rotary movement with stainless steel bushings and socket;
 - .4 clear acrylic window;

- .5 dual scale white dial with a scale range such that working pressure of system is at approximate mid-point of scale;
- .6 black pointer.
- .2 Pressure gauge accessories and additional requirements as follows:
 - .1 a bronze ball type shut-off valve is to be provided in the piping to each pressure gauge;
 - .2 each pressure gauge for piping and equipment with normal everyday flow is to be equipped with a brass pressure snubber;
 - .3 pressure gauges in fire protection piping must be ULC listed and labelled;
- .3 Thermometers as follows:
 - .1 round, 125 mm (5") diameter, adjustable (90°) angle bimetal dial type thermometers, each accurate to within 1% of full scale;
 - .2 hermetically sealed stainless steel case with stainless steel ring;
 - .3 dampened bimetal coil;
 - .4 calibration adjustment screw;
 - .5 white aluminum dual scale dial with black and blue markings and a range such that working temperature of system is approximate mid-point of the scale;
 - .6 black aluminum pointer;
 - .7 double strength glass window;
 - .8 12 mm (½") NPT connection with 6.4 mm (¼") diameter stainless steel stem;
 - .9 suitable thermowell.
- .4 Acceptable manufacturers are:
 - .1 H.O. Trerice Co.;
 - .2 Weiss Instruments;
 - .3 Ashcroft.

2.08 EQUIPMENT BELT DRIVES

- .1 ANSI/RMA Standard V-belt type rated at minimum 1.5 times motor nameplate rating, and in accordance with following requirements:
 - .1 belts are to be reinforced cord and rubber, and multiple belts are to be matched sets;

- .2 sheaves are to be cast iron or steel, secured to shafts with removable keys unless otherwise specified, standard adjustable pitch ($\pm 10\%$ range) for motors under 10 HP, fixed pitch type with split tapered bushing and keyway for motors 10 HP and larger, and, if required, replaced as part of mechanical work to suit system air/water quantity testing and balancing work;
- .3 motor slide rail adjustment plates are to allow for centre line adjustment.
- .2 Supply a spare belt set (tagged and identified) for each belt drive and hand to Owner upon Substantial Performance of the Work.

2.09 EQUIPMENT DRIVE GUARDS AND ACCESSORIES

- .1 For V-belt drives – removable, 4-sided, fully enclosed, galvanized sheet steel guards to OSHA standards, cleaned, factory primed and painted with yellow equipment enamel, complete with a 2-piece full length hinged front panel to permit belt maintenance or replacement without removing guard, and 40 mm (1-1/2") diameter tachometer openings at each shaft location.
- .2 For flexible couplings – removable "U" shaped galvanized steel guards to OSHA Standards with a 2.3 mm (3/32") thick frame and expanded mesh face.
- .3 For unprotected fan inlets and outlets – unless otherwise specified, removable 20 mm (3/4") galvanized steel wire mesh with galvanized steel frames, all to OSHA Standards.

2.10 ELECTRIC MOTORS

- .1 Unless otherwise specified, motors are to conform to NEMA Standard MG1, applicable IEEE Standards, and applicable CSA C22.2 Standards, and are to meet NEMA standards for maximum sound level ratings under full load. Confirm motor voltages prior to ordering.
- .2 Vertically mounted and submersible motors are to be purposely designed for mounting in this attitude.
- .3 Efficiency of 1-phase motors to 1 HP is to be in accordance with CAN/CSA C747. Efficiency of 3-phase motors 1 HP and larger is to be in accordance with CAN/CSA C390 or IEEE 112B.
- .4 Unless otherwise specified, 1-phase motors smaller than 1/2 HP are to be 115 volt, continuous duty capacitor start type with an NEMA 48 or 56 frame size, solid base, heavy-gauge steel shell with solid die-cast end shields, dynamically balanced die-cast rotor, integral automatic reset thermal overload protection, Class "B" insulation, and a 1.15 service factor at 40°C (105°F) ambient temperature.
- .5 Explosion-proof 1-phase motors are to be totally enclosed, fan cooled, 115 volt continuous duty capacitor start type in accordance with CSA C22.2 No. 145, as specified for standard 1-phase motors but suitable for use in Class 1 Group D hazardous locations and complete with a rolled steel shell and a 1.0 service factor at 40°C (105°F) ambient temperature.

- .6 Unless otherwise specified, motors ½ HP and larger are to be totally enclosed, fan cooled, 3-phase, T-frame, squirrel cage continuous duty induction motors suitable for voltages indicated on Drawings, NEMA Design "B" for normal starting torque or Design "C" for high starting torque as required by the application, each complete with Class "B" insulation, a 1.15 service factor at 40°C ambient temperature, grease lubricated open ball bearings with grease fittings to permit re-lubrication without dismantling motor, a cast iron frame with cast iron feet where required, cast iron end bracket and precision machined bearing fit, and balanced carbon steel shaft assembly with die-cast aluminum rotor windings.
- .7 Explosion-proof 3-phase motors are to be totally enclosed fan cooled motors in accordance with CSA C22.2 No. 145, generally as specified above for standard 3-phase motors but suitable for use in Class 1 Group D hazardous locations and with a 1.0 service factor at 40°C (105°F) ambient temperature.
- .8 Unless otherwise indicated, motors 30 HP and larger are to be complete with a heat sensing PTC thermistor in the end turn of stator winding for each phase and connected in series inside motor with 2 marked leads brought out to motor conduit box.
- .9 Motors for equipment with variable frequency drives are to be generally as specified above but inverter duty type to NEMA Standard MG-1 Part 31, quantified by CSA for operation from a variable frequency drive of type specified, and complete with Class "H" insulation. Motors are to be equipped with AEGIS, or approved equal, shaft grounding ring system to protect bearings from damage by diverting harmful shaft voltages and bearing currents to ground.
- .10 Motors 150 HP and larger with "wye-delta" reduced voltage starters are to be complete with six leads for connection to motor starter.
- .11 Motors for equipment which is scheduled or specified with a corrosion resistant coating or constructed from corrosion resistant materials are to be factory coated with a primer and epoxy paint finish.
- .12 Acceptable manufacturers are:
 - .1 TECO-Westinghouse Motors (Canada) Inc.;
 - .2 Canadian General Electric;
 - .3 Baldor Electric Co.;
 - .4 U.S. Electrical Motors;
 - .5 Weg Electric Corp.;
 - .6 Marathon Electric;
 - .7 Toshiba Corp.;
 - .8 Leeson Canada.

2.11 MOTOR STARTERS AND ACCESSORIES

- .1 Motor starters must be capable of starting associated motors under the imposed loads. Confirm starter voltage matches motor prior to ordering.

- .2 Unless otherwise specified, starters for 1-phase motors are to be 115 volt, thermal overload protected manual starting switches with a neon pilot light, a surface or recessed enclosure to suit the application, and, where automatic operation is required, a separate H-O-A switch in an enclosure to match starter enclosure.
- .3 Unless otherwise specified, starters for 3-phase motors less than 50 HP are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with an overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts..
- .4 Unless otherwise specified, starters for 3-phase motors 50 HP to 150 HP are to be reduced voltage, non-reversing, auto-transformer type starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, and auxiliary contacts.
- .5 Unless otherwise specified, starters for 3-phase motors 150 HP and larger are to be reduced voltage, non-reversing, closed transition "wye-delta" starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, and auxiliary contacts.
- .6 Starters for 2-speed double winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .7 Starters for 2-speed single winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .8 Starters for reversible motors for cooling towers are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to allow fan(s) to coast down to a stop before being operated in reverse rotation.
- .9 Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings:
 - .1 enclosures located in sprinklered areas – Type 2;
 - .2 enclosures exposed to the elements – Type 3R, constructed of stainless steel;
 - .3 enclosures inside the building in wet areas – Type 3R, constructed of stainless steel;
 - .4 enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application;
 - .5 enclosures except as noted above – Type 1;
 - .6 enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.

- .10 Motor control centres are to be multi-unit, 2.28 m (9') high, NEMA Class 1, type "B", factory assembled, dead front, floor mounted, free-standing motor control centre with tin plated copper bus and an NEMA Type 1 or Type 2 enclosure as for loose starters specified above. Each motor control centre is to be complete with starters as specified above, load and control wiring terminal boards, and required facilities for line and load side power wiring connections.
- .11 Disconnect switches for motor control centres are to be heavy-duty, CSA certified, front operated switches as per motor starter schedule, each complete with a handle suitable for padlocking in "off" position and arranged so that door cannot be opened with handle in "on" position and an NEMA enclosure as specified for loose starters. Fusible units are to be complete with fuse clips to suit fuse types specified below.
- .12 Fuses are to be, unless otherwise scheduled or specified, English Electric Ltd. HRC fuses, Form I Class "J" for constant running equipment and Form II Class "C" for equipment that cycles on and off.
- .13 Acceptable manufacturers are:
 - .1 Rockwell Automation Inc. - Allen-Bradley;
 - .2 Eaton Corp. – Cutler-Hammer;
 - .3 Eaton Corp. – Moeller Electric;
 - .4 Siemens Canada;
 - .5 Schneider Electric.

2.12 SPRINKLER PROOFING

- .1 Provide drip shields for protection of surface mounted equipment enclosures from water spray and dripping of liquids. Features of shields include:
 - .1 factory constructed by respective equipment manufacturers;
 - .2 constructed from non-combustible materials (sheet steel);
 - .3 enamel painted to match equipment;
 - .4 surfaces and edges filled/sanded smooth prior to painting;
 - .5 supported from equipment with structural steel rods/metal framing or other method approved by Consultant;
 - .6 structural support finish painted to match shield.
- .2 Include with equipment shop drawings, detailed dimensions of drip shields and methods of supporting.
- .3 Equipment with top cable/conduit entries to include additional sealing of entries with gasketting and/or waterproof sealant to prevent water from entering enclosure.
- .4 Design ventilation louvers such that live components are not exposed to water spray and dripping liquids.

- .5 Above requirements are additional minimum "sprinkler proof" standards for equipment specified as NEMA 1, 2 or 12.

- .6 Obtain CSA approval where required by local governing authorities.

2.13 MECHANICAL WORK IDENTIFICATION MATERIALS

- .1 Equipment nameplates are to be minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (1/2" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2-1/2") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:

- .1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved wording to completely identify equipment and its use with no abbreviations;
- .2 wording is generally to be as per drawings, i.e. Fan EF-1, and is to include equipment service and building area/zone served, but must be reviewed prior to engraving;
- .3 supply stainless steel screws for securing nameplates in place;
- .4 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.

- .2 Valve tags are to be coloured, 40 mm (1-1/2") square, 2-ply laminated plastic with bevelled edges, red-white, green-white, yellow-black, etc., to match piping identification colour, each complete with a 3.2 mm (1/8") diameter by 100 mm (4") long brass plated steel bead chain, and four lines of engraved maximum size identification wording, i.e.:

VALVE V12
200 mm (8")
CHILL. WATER
NORMALLY OPEN

- .3 Standard pipe identification is to be equal to Smillie McAdams Summerlin Ltd., Brady or Primark Manufacturing Inc. vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:
 - .1 for pipe less than or equal to 150 mm (6") diameter, coiled type snap-on markers of a length to wrap completely around pipe or pipe insulation;
 - .2 for pipe larger than 150 mm (6") diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.
- .4 Identification wording and colours for pipe identification materials are to be as follows:

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
domestic cold water	green	DOM. COLD WATER
domestic hot water supply	green	DOM. HW SUPPLY
domestic hot water recirculation	green	DOM. HW RECIRC.
tempered domestic water	green	TEMP. DOM. WATER
storm drainage	green	STORM
sanitary drainage	green	SAN.
plumbing vent	green	SAN. VENT
acid sanitary drainage	yellow	ACID DRAIN
acid drainage vent	yellow	ACID VENT
fire protection standpipe	red	F.P. STANDPIPE
natural gas	to Code	to Code, c/w pressure
natural gas vent	to Code	to Code
propane gas	to Code	to Code, c/w pressure
propane gas vent	to Code	to Code
heating water supply	yellow	HTG. WTR. SUPPLY
heating water return	yellow	HTG. WTR. RETURN
heating water drain	yellow	HTG. WTR. DRAIN
glycol heating supply	yellow	GLY. HTG. SUPPLY
glycol heating return	yellow	GLY. HTG. RETURN
glycol heating drain	yellow	GLY. HTG. DRAIN
refrigerant suction	yellow	REFRIG. SUCTION
refrigerant liquid	yellow	REFRIG. LIQUID
refrigerant hot gas	yellow	REFRIG. HOT GAS
compressed air (< 700 kPa)	green	kPa COMP. AIR
compressed air (>700 kPa)	yellow	kPa COMP. AIR

- .1 Colours for pipe identification legends and directional arrows are to be as follows:

IDENTIFICATION COLOUR	LEGEND & ARROW COLOUR
yellow	black
green	white
red	white

- .2 Duct identification is to be custom made Mylar stencils with 50 mm (2") high lettering to accurately describe duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow, and coloured ink with ink pads and roller applicators. Ink colour is generally to be black but must contrast with lettering background.

3. EXECUTION

3.01 GENERAL PIPING AND DUCTWORK INSTALLATION REQUIREMENTS

- .1 Unless otherwise specified, locate and arrange horizontal pipes and ducts above or at ceiling on floors, arranged so that under consideration of all other work in area, maximum ceiling height and/or usable space is maintained. If required to maintain ceiling heights, reroute and/or resize ductwork, with Consultant's approval.
- .2 Unless otherwise specified, install work concealed in finished spaces, and concealed to degree possible in partially finished and unfinished spaces. Refer to and examine Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Walls which are painted are considered finished.
- .3 Install pipes and ducts parallel to building lines and to each other.
- .4 Neatly group and arrange exposed work.
- .5 Locate work to permit easy access for service or maintenance as required and/or applicable. Locate valves, dampers and any other equipment which will or may need maintenance or repairs and which are to be installed in accessible construction so as to be easily accessible from access doors. Where valves, dampers and similar piping or ductwork accessories occur in vertical services in shafts, pipe spaces or partitions, locate accessories at floor level.
- .6 Make connections between pipes of different materials using adapters suitable for application. Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe.
- .7 Comply with equipment and material manufacturer's installation instructions unless otherwise specified herein or on drawings, and unless such instructions contradict governing codes and regulations.
- .8 Carefully clean ducts, pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.
- .9 Install piping and ductwork which are to be insulated so that they have sufficient clearance to permit insulation and finish to be applied continuously and unbroken around pipe or duct, except for ductwork at fire barriers, in which case insulation will be terminated at each side of the duct fire damper.
- .10 Inspect surfaces and structure prepared by other trades before performing work. Verify surfaces or structure to receive work has no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of work will constitute acceptance of such surfaces as being satisfactory.

- .11 Any ferrous piping that exhibits in excess of 5% surface rust, either inside or outside or both, is to be wire brush cleaned to bare metal and coated with suitable primer. Steel pipe, fittings and accessories are to be free of corrosion and dirt when work is complete or prior to being concealed from view. Where dirt is evident, clean piping prior to being concealed.
- .12 Provide continuous galvanized sheet metal drip pan under drain, water and water solution piping extending through rooms with electrical equipment such as electrical, elevator equipment and transformer rooms, and other spaces provided primarily for the installation of electrical equipment. Drip pans are to be complete with a drain pipe connection and drain piping is to be extended to closest drain.
- .13 For factory applied finishes, repaint or refinish surfaces damaged during shipment and installation. Quality of repair work is to match original finish. This requirement also applies to galvanized finishes.
- .14 Where mechanical work is located in high humidity areas where ferrous metal products will be subject to corrosion and protection for such products is not specified, provide finishes on products to protect against corrosion or provide products which will not corrode in the environment, i.e. aluminium ductwork, copper or stainless steel pipe, etc.
- .15 Provide screwed unions or flanges in piping connections to equipment and in regular intervals in long (in excess of 12 m [40']) piping runs to permit removal of sections of piping.
- .16 Unless otherwise specified and except where space limitations do not permit, piping elbows are to be long radius. Eccentric reducers are to be installed with straight side at top of piping.

3.02 PIPE JOINT REQUIREMENTS

- .1 Do not make pipe joints in walls or slabs.
- .2 Ream piping ends prior to making joints.
- .3 Properly cut threads in screwed steel piping and coat male threads only with Teflon tape or paste, or an equivalent thread lubricant. After pipe has been screwed into fitting, valve, union, or piping accessory, not more than 2 pipe threads are to remain exposed.
- .4 Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove scale and oxide from bevels and leave smooth and clean. Use factory made welding tees or welding outlet fittings for piping branches off mains. Do not use shop or site fabricated fittings unless written approval has been obtained.
- .5 Welded joints are to be made by CWB certified licensed journeyman welders qualified in accordance with CSA B51, Boiler Pressure Vessel and Pressure Piping Code, and who are in possession of a proper certificate of qualification for each procedure to be performed. Each weld is to be identified with the welder's identification symbol, and welds are not to be concealed until they have been inspected and approved. Electrodes are to be in accordance with CSA W48 Series, Electrodes, and requirements of CAN/CSA W117.2, Safety in Welding, Cutting and Allied Processes are to be followed.

- .6 Unless otherwise specified, make flanged joints with Garlock 5500 or equivalent gasket materials to suit the application, and bolts and nuts. Bolts are not to be longer than length necessary to screw nut up flush to the end of bolt. Bolts used for flanged connections in piping with a working pressure of 690 kPa (100 psi) and greater are to be ASTM A-193 Grade B-7, with heavy hexagon nuts to ASTM A-194 CL-2H. Provide suitable washers between each bolt head and flange and between each nut and flange.
- .7 A random check of bolted flanged connections will be made to verify flanged connections are properly mated with no shear force acting on bolts. Supply labour to disconnect and reconnect selected flanged joints. If improperly mated joints are found, remove and reinstall affected piping so flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.
- .8 Unless otherwise specified make soldered joints in copper piping using flux suitable for and compatible with type of solder being used. Clean the outside of pipe end and inside of fitting, valve, or similar accessory prior to soldering.
- .9 Install mechanical joint fittings and couplings in accordance with manufacturer's instructions.
- .10 Grooves are to be rolled. Make arrangements with coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to manufacturer's instructions with respect to pipe grooving, support, type of gasket required, anchoring and guiding the grooved piping system.
- .11 If pressure crimped couplings and fittings are used, ensure gaskets are fully compatible with piping fluid, and valves and piping accessories are suitable. Use only fitting manufacturer supplied crimping equipment. Comply with manufacturer's latest published specification, instructions, and recommendations with respect to pipe, coupling, and fitting preparation and installation, and support, anchoring and guiding of the piping system.
- .12 Solvent weld PVC piping in 2 parts, primer stage and cementing stage, in accordance with manufacturer's recommendations, ASTM D2855, and CSA requirements.
- .13 Install PVC piping with gasketed joints in accordance with manufacturer's current published specifications, instructions and recommendations, and CSA requirements.

3.03 INSTALLATION OF PIPE SLEEVES

- .1 Where pipes pass through concrete and/or masonry surfaces provide pipe sleeves as follows:
 - .1 in poured concrete slabs – unless otherwise specified, minimum 16 gauge flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves;
 - .2 in concrete or masonry walls – Schedule 40 galvanized steel pipe or Class 4000 cast iron pipe.
- .2 Sleeves in waterproofed slabs or walls are to be lengths of Schedule 40 mild galvanized steel pipe with a waterstop plate in accordance with drawing detail. Provide waterproof sleeves in following locations:
 - .1 in mechanical room floor slabs, except where on grade;

- .2 in slabs over mechanical, fan, electrical and telephone equipment rooms or closets;
- .3 in floors equipped with waterproof membranes;
- .4 in roof slab;
- .5 in waterproof walls.
- .3 Size sleeves, unless otherwise specified, to leave 12 mm ($\frac{1}{2}$ ") clearance around pipes, or where pipe is insulated, a 12 mm ($\frac{1}{2}$ ") clearance around pipe insulation.
- .4 Pack and seal void between pipe sleeves and pipe or pipe insulation in non-fire rated construction for the length of sleeves as follows:
 - .1 pack sleeves in interior construction with mineral wool and seal both ends of sleeves with non-hardening silicone base caulking compound;
 - .2 pack sleeves in exterior walls above grade with mineral wool and seal both ends of sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified;
 - .3 seal sleeves in exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified.
- .5 Where sleeves are required in masonry work, accurately locate and mark sleeve location, and hand sleeves to mason for installation.
- .6 Terminate piping for sleeves that will be exposed so sleeve is flush at both ends with building surface concerned so sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to terminate 100 mm (4") above finished floor.
- .7 "Gang" type sleeving will not be permitted.
- .8 Where sleeves are provided in non-fire rated construction for future piping, or where piping has been removed from existing sleeves, cap and seal both ends of sleeved opening.

3.04 INSTALLATION OF WATERPROOF MECHANICAL SEALS

- .1 Provide watertight link type mechanical seals in exterior wall openings.
- .2 Assemble and install each mechanical seal in accordance with manufacturer's instructions.
- .3 After installation, periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until seal is completely watertight.

3.05 DUCT OPENINGS

- .1 Duct openings, air inlet and outlet openings, fire damper and similar openings will be provided in new poured concrete work, masonry, drywall and other building surfaces by trade responsible for particular construction in which opening is required.

- .2 Size openings for fire dampers to 600 mm (24") high to suit damper arrangement with folding blade out of air stream.
- .3 For duct openings except where fire dampers are required, pack and seal space between duct or duct insulation and duct opening as specified above for pipe openings in non-fire rated construction.

3.06 SLEEVE AND FORMED OPENING LOCATION DRAWINGS

- .1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.
- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

3.07 INSTALLATION OF PIPE ESCUTCHEON PLATES

- .1 Provide escutcheon plates suitably secured over exposed piping passing through finished building surfaces. A finished building surface is any surface with a factory finish or that receives a site applied finish.
- .2 Install plates so they are tight against building surface concerned, completely covering pipe sleeves and/or openings, except where waterproof sleeves extend above floors, in which case fit plate tightly around sleeve.

3.08 INSTALLATION OF FASTENING AND SECURING HARDWARE

- .1 Provide fastening and securing hardware required for mechanical work to maintain installations attached to structure or to finished floors, walls and ceilings in a secure and rigid manner capable of withstanding dead loads, live loads, superimposed dead loads, and any vibration of installed products.
- .2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.
- .3 Where floor, wall or ceiling construction is not suitable to support loads, provide additional framing or special fasteners to ensure proper securement to structure that is to support the products. Provide reinforcing or connecting supports where required to distribute loading to structural components.
- .4 Obtain written consent before using explosive actuated fastening devices. If consent is obtained, comply with requirements of CAN/CSA Z166.1 and CAN/CSA Z166.2.
- .5 Do not attach fasteners to steel deck without written consent from Consultant.

3.09 INSTALLATION OF PIPE HANGERS AND SUPPORTS

- .1 Provide required pipe hangers and supports.

- .2 Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from structure only.
- .3 For insulated pipe, size hanger or support to suit diameter of insulated pipe and install hanger or support on outside of insulation and insulation finish.
- .4 Support requirements for underground piping are as follows:
 - .1 support underground pipe, unless otherwise specified, on a well compacted bed of dry, natural, undisturbed earth free from rocks or protrusions of any kind, or on compacted material as specified;
 - .2 support underground service piping penetrating building exterior walls or foundations to prevent pipe damage if minor building settlement occurs, all as per drawing detail;
 - .3 ensure bedding and supports for underground pipes are flat and true and allowances are made for pipe hubs, couplings, or other protrusions so no voids are left between pipe and bedding.
- .5 Unless otherwise shown or specified, hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in Part 2 of this Section. Unless otherwise shown or specified, hangers for suspended pipe less than or equal to 25 mm (1") dia. are to be clevis type or adjustable ring type, and hangers for suspended pipe greater than or equal to 40 mm (1-½") dia. are to be adjustable clevis type.
- .6 Space hangers and supports in accordance with following:
 - .1 cast iron pipe – hang or support at every joint with maximum 2.4 m (8') spacing;
 - .2 plastic pipe – conform to pipe manufacturer's recommended support spacing;
 - .3 glass pipe – conform to pipe manufacturer's recommended support spacing and support requirements;
 - .4 copper and steel pipe – hang or support at spacing in accordance with following schedule:

PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
to 25 mm (1")	2.4 m (8')	1.8 m (6')
40 mm (1-½")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2-½")	3.6 m (12')	3.0 m (10')
75 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3-½")	3.6 m (12')	3.6 m (12')
100 mm (4")	4.2 m (14')	3.6 m (12')
250 mm (10")	6.0 m (20')	
300 mm (12")	6.7 m (22')	

- .5 flexible grooved pipe/coupling joint piping – as above but with not less than one hanger or support between joints.
 - .7 Where pipes change direction, either horizontally or vertically, provide a hanger or support on horizontal pipe not more than 300 mm (12") from elbow, and where pipes drop from tee branches, support tees in both directions not more than 50 mm (2") on each side of tee.
 - .8 When pipes with same slope are grouped and a common hanger or support is used, space hanger or support to suit spacing requirement of smallest pipe in group and secure pipes in place on common hanger or support.
 - .9 Provide roller hangers or supports for heat transfer piping greater than or equal to 150 mm (6") diameter and conveying a material 75°C (170°F) or greater to facilitate pipe movement due to expansion and contraction, and at each hanger or support tack weld a steel protection saddle to pipe to protect piping insulation.
 - .10 Unless otherwise shown or specified, support vertical piping by means of supports specified in Part 2 of this Section, spaced in accordance with following:
 - .1 support vertical pipes at maximum 3 m (10') intervals or at every floor, whichever is lesser;
 - .2 for sections of vertical piping with a length less than 3 m (10'), support pipe at least once;
 - .3 for vertical cast iron plain end pipe (mechanical joint type), secure riser or pipe clamp around pipe under a flange integral with pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support;
 - .4 for vertical steel pipe risers in excess of 3 m (10'), weld shear lugs to pipe to carry load;
 - .5 for vibration isolated piping risers, provide rubber-steel-rubber vibration isolation pads between riser clamps and floor.
 - .11 Each hanger, support or securement for horizontal bare copper tubing is to be plastic coated to prevent direct contact between pipe and ferrous hanger. Each wall or floor clamp for vertical bare copper piping is to be isolated from pipe by means of strips of flexible rubber inserts. Use of painted ferrous hangers and supports, including those painted with copper coloured paint, is not acceptable. Site application of tape or other types of isolation is not acceptable.
 - .12 For insulated horizontal piping less than or equal to 40 mm (1-½") diameter, provide galvanized steel insulation protection shields between insulation and hanger or support. Install shields immediately after pipe is insulated.
 - .13 Do not support piping from steel deck without written consent from Consultant.
- 3.10 INSTALLATION OF ROOF MOUNTED PIPE SUPPORTS
- .1 Supply manufactured roof supports as per Part 2 of this Section to accommodate piping.
 - .2 The use of wood for supporting piping is not permitted.

- .3 Provide supports spaced so deflection of piping does not exceed 1/240 of span.
- .4 Piping support spacing is to be as per manufacturer's recommendations or as indicated in schedule below, but in no case greater than 3 m (10') on centre.
- .5 Supports are to be provided upstream and downstream of all corners, valves, and branch tee-offs.
- .6 Contractor is responsible for piping supports meeting the requirements of all local codes and standards (ex. TSSA, Natural Gas Utility requirements, etc.).
- .7 Set framing posts into bases and assemble framing structure as indicated.
- .8 Use galvanized fasteners for galvanized framing and stainless steel fasteners for stainless steel framing.
- .9 Piping supports are to be provided as follows:
 - .1 For Gas Lines 2-1/2 inches (64 mm) in Diameter or Less, up to 10 inches (254 mm) above roof: Portable Pipe Hanger Model number: SS8.
 - .2 For Gas Lines 3-1/2 inches (89 mm) in Diameter or less, up to 16 inches (406 mm) above roof: Portable Pipe Hanger Model number PP10.
 - .3 For Gas Lines 4 to 6 inches (100-150 mm) in Diameter, up to 12 inches (305 mm) above roof: Portable Pipe Hanger Model number RB18.
 - .4 For single Gas Lines 3 to 8 inches (80-200 mm) in Diameter: Portable Pipe Hanger Model number PS 1-2.
 - .5 For insulated piping mounted on roof: Portable Pipe Hanger Model number PSE.
 - .6 Option for Multiple Lines: Portable Pipe Hanger Model number PSE custom.
- .10 Spacing requirements for supports are to be confirmed by manufacturer. Unless otherwise noted, support roof mounted piping at spacing according to the following schedule:

PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
Less than 25 mm (1")	1.2 m (4')	Continuous Support
25 mm (1")	2.4 m (8')	2 m (6')
32 mm (1-1/4) and Greater	3.0 m (10')	2 m (6')

- .11 For copper tubing less than 25mm (1"), provide heavy gauge galvanized metal pan (or equivalent) running between supports (pan shall be constructed to support pedestrian loads). The refrigerant piping shall be mounted on the pan for continuous support c/w galvanized pipe clamp fasteners.

3.11 SUPPLY OF ACCESS DOORS

- .1 Supply access doors to give access to mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on drawings.
- .2 Before commencing installation of mechanical work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors. Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange mechanical work to suit.
- .3 Access doors will be installed by trade responsible for particular type of construction in which doors are required. Supply access doors to trade installing same at proper time.
- .4 Wherever possible, access doors to be of a standard size for each application. Confirm exact dimensions and minimum size restrictions with Consultant prior to ordering.
- .5 Group piping and ductwork to ensure minimum number of access doors is required.
- .6 Submit a sample of each proposed access door for review prior to ordering.
- .7 Coordinate with Electrical Contractor and General Trades Contractor to ensure access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and work involving both mechanical and electrical services should, where possible, be accessible from common access door. Coordinate work to ensure common location access doors are not supplied by both Mechanical Divisions and Electrical Divisions.

3.12 INSTALLATION OF VALVES

- .1 Generally, valve locations are indicated or specified on drawings or specified in Sections of the Specification where valves are specified, however, regardless of locations shown or specified, following requirements apply:
 - .1 provide shut-off valves to isolate systems, at base of vertical risers, in branch take-offs at mains and risers on floors, to isolate equipment, to permit work phasing as required, and wherever else required for proper system operation and maintenance;
 - .2 install shut-off valves with handles upright or horizontal, not inverted, and located for easy access;
 - .3 unless otherwise specified, provide a check valve in discharge piping of each pump;
 - .4 valve sizes are to be same as connecting pipe size;
 - .5 valves are to be permanently identified with size, manufacturer's name, valve model or figure number and pressure rating, and wherever possible, valves are to be product of same manufacturer;
 - .6 for valves in insulated piping, design of valve stem, handle and operating mechanism is to be such that insulation does not have to be cut or altered in any manner to permit valve operation.

3.13 INSTALLATION OF PRESSURE GAUGES AND THERMOMETERS

- .1 Provide pressure gauges in following locations:

- .1 in valved tubing across suction, suction strainer (if applicable), and discharge piping of each circulating pump;
 - .2 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, heat exchangers, main coils, etc.;
 - .3 in expansion tank(s);
 - .4 in separate domestic hot water storage tank(s);
 - .5 at top most outlet in each standpipe fire protection system riser;
 - .6 in piping at each side of a pressure reducing valve;
 - .7 in potable water service piping downstream of meter;
 - .8 wherever else shown and/or specified.
- .2 Provide thermometers in following locations:
- .1 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, cooling towers, heat exchangers, main coils, etc., unless temperature indication is supplied with equipment;
 - .2 wherever else shown and/or specified.
- .3 Conform to following installation requirements:
- .1 for installation of thermometers in piping wells, provide a coat of metallic base heat transfer paste or grease in piping well;
 - .2 for pressure gauges in piping at equipment locations, install pressure gauge between equipment and first pipe fitting;
 - .3 locate, mount and adjust instruments so they are easily readable;
 - .4 where pressure gauges and/or thermometers are located at high level or in an area where they cannot be easily seen, provide remote reading instruments.
- 3.14 INSTALLATION OF EQUIPMENT DRIVE GUARDS AND ACCESSORIES
- .1 Provide OSHA guards for exposed accessible rotating parts such as belt drives, couplings, fan wheels, and shaft ends on mechanical equipment.
 - .2 Install belt guards to allow movement of motors for adjusting belt tension.
 - .3 Provide a means to permit lubrication and use of test instruments with guards in place.
 - .4 Secure guards to equipment or equipment base but do not bridge sound or vibration isolation.
 - .5 Where equipment oil level gauges, oil reservoirs, grease cups, or grease gun fittings are integral with equipment but are not easily accessible for service, extend to an accessible location using aluminium or copper tubing.

3.15 MECHANICAL WORK IDENTIFICATION

- .1 Identify new exposed piping and ductwork as per Part 2 of this Section in locations as follows:
 - .1 at every end of every piping or duct run;
 - .2 adjacent to each valve, strainer, damper and similar accessory;
 - .3 at each piece of connecting equipment;
 - .4 on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;
 - .5 at 6 m (20') intervals on pipe and duct runs exceeding 6 m (20') in length;
 - .6 at least once in each room, and at least once on pipe and duct runs less than 6 m (20') in length.
- .2 Unless otherwise specified identify new concealed piping and ductwork as per Part 2 of this Section in locations as follows:
 - .1 at points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas;
 - .2 at maximum 6 m (20') intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;
 - .3 at each access door location;
 - .4 at each piece of connected equipment, automatic valve, etc..
- .3 Provide an identification nameplate for equipment provided as part of this project, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate nameplates in the most conspicuous and readable location.
- .4 Paint new natural and/or propane gas piping with primer and 2 coats of yellow paint in accordance with Code requirements and requirements of Painting Section in Division 09. Identify piping at intervals as specified above.
- .5 Provide an identification nameplate for each motor starter or disconnect switch located in a motor control centre or on a motor starter panel, and on each individually mounted starter provided as part of mechanical work, and on each disconnect switch provided as part of the electrical work for motorized equipment provided as part of mechanical work.
- .6 For electrically traced mechanical work, identification wording is to include "ELECTRICALLY TRACED".
- .7 Tag valves and prepare a valve tag chart in accordance with following requirements:
 - .1 attach a valve tag to each new valve, except for valves located immediately at equipment they control;

- .2 prepare a computer printed valve tag chart to list tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);
 - .3 if an existing valve tag chart is available at site, valve tag numbering is to be an extension of existing numbering and new valve tag chart is to incorporate existing chart;
 - .4 frame and glaze one copy of chart and, unless otherwise directed, affix to a wall in each main Mechanical and/or Equipment Room;
 - .5 include a copy of valve tag chart in each copy of operating and maintenance instruction manuals;
 - .6 hand an identified CD of valve tag chart to Owner at same time O & M Manuals are submitted.
 - .8 Where shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in ceiling panel material, or stickers equal to Brady "Quick Dot" on ceiling grid material to indicate locations of items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:
 - .1 HVAC piping valves and equipment: yellow
 - .2 fire protection valves and equipment: red
 - .3 plumbing valves and equipment: green
 - .4 HVAC ductwork dampers and equipment: blue
 - .5 control system hardware and equipment: orange
- 3.16 FINISH PAINTING OF MECHANICAL WORK
- .1 Finish painting of exposed mechanical work is specified in Division 09 and is part of the work of Division 09.
- 3.17 PIPE LEAKAGE TESTING
- .1 Before piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test piping for leakage.
 - .2 Tests are to be witnessed by Consultant and/or Owner's representative, and, where required, representatives of governing authorities. Give ample notice of tests in writing and verify attendance. Have completed test report sheets dated and signed by those present to confirm proper test results.
 - .3 When circumstances prevent scheduled tests from taking place, give immediate and adequate notice of cancellation to all who were scheduled to attend.
 - .4 Gravity Drainage and Vent Piping
 - .1 Test piping in accordance with local governing building code.

- .2 After fixtures and fittings are set and pipes are connected to building drain or drains, turn on water into pipe, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Perform a smoke test if required by local governing authorities.
- .5 Pumped Drainage Piping
 - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.
- .6 Domestic Water Piping
 - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.
- .7 Heat Transfer (HVAC) System Piping
 - .1 Test piping with cold water at a pressure of 1035 kPa (150 psi) for a minimum of 2 hours.
- .8 Natural Gas Piping
 - .1 Test piping in accordance with requirements of CAN/CSA B149.1 and any additional requirements of local governing authorities.
 - .2 After completion of the verification test, locate required tag stating results of the verification test at the point of entry of gas main into building, affixed to the pipe in a secure manner.
 - .3 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.
- .9 Compressed Air Piping
 - .1 Test piping with dry compressed air or nitrogen at 690 kPa (100 psi) for a minimum of 2 hours.
 - .2 Test piping joints with a water-soap solution while piping is under pressure to detect leaks.
- .10 Following requirements apply to all testing:
 - .1 ensure piping has been properly flushed, cleaned and is clear of foreign matter prior to pressure testing;
 - .2 temporarily remove or valve off piping system specialties or equipment which may be damaged by test pressures prior to pressure testing systems, and flush piping to remove foreign matter;
 - .3 when testing is carried out below highest level of the particular system, increase test pressure by the hydrostatic head of 7 kPa (1 psi) for every 600 mm (24") below the high point;
 - .4 include for temporary piping connections required to properly complete tests;

- .5 piping under test pressure is to have zero pressure drop for length of test period;
- .6 make tight leaks found during tests while piping is under pressure, and if this is impossible, remove and refit piping and reapply test until satisfactory results are obtained;
- .7 where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions;
- .8 tests are to be done in reasonably sized sections so as to minimize number of tests required;
- .9 in addition to leakage tests specified above, demonstrate proper flow throughout systems including mains, connections and equipment, as well as proper venting and drainage, and include for any necessary system adjustments to achieve proper conditions.

3.18 SUPPLY OF MOTOR STARTERS AND ACCESSORIES

- .1 Unless otherwise shown or specified, supply a starter for each item of motorized equipment.
- .2 Where 3-phase starters are indicated in motor control centres, supply motor control centres with starters and bolt to a concrete housekeeping pad.
- .3 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from a motor control centre, provide a disconnect switch in motor control centre in lieu of a motor starter.
- .4 Where 3-phase starters are indicated and/or scheduled to be mounted on a motor starter panel, starters will be mounted and connected, complete with panels and splitter trough, as part of electrical work. Hand starters to electrical trade at site when they are required.
- .5 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from a motor starter panel, a disconnect switch will be provided on motor starter panel as part of electrical work.
- .6 Unless otherwise specified or shown on drawings, 1-phase motor starters will be mounted adjacent to equipment they serve and connected complete as part of electrical work. Hand starters to electrical trade at site at the proper time.

3.19 ELECTRICAL WIRING WORK FOR MECHANICAL WORK

- .1 Unless otherwise specified or indicated, following electrical wiring work for mechanical equipment will be done as part of the electrical work:
 - .1 "line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from starters or disconnects to equipment;
 - .2 "line" side power wiring to individual wall mounted starters, and "load" side wiring from starters to equipment;

- .3 "line" side power wiring to pre-wired power and control panels and variable frequency drives (VFD), and "load" side power wiring from the panels and VFD's to equipment;
 - .4 provision of receptacles for plug-in equipment;
 - .5 provision of disconnect switches for motors in excess of 10 m (30') from starter location, or cannot be seen from starter location, and associated power wiring;
 - .6 motor starter interlocking in excess of 24 volts;
 - .7 wiring from motor winding thermistors in motors 30 HP and larger to motor starter contacts;
 - .8 120 volt power connections to electrical receptacles integral with small ceiling exhaust fans, including wiring through light switches or speed controllers;
 - .9 120 volt wiring connections to lighting fixture/switch combinations integral with air handling units;
 - .10 120 volt wiring connections to duplex receptacles integral with air handling unit control panels.
- .2 Mechanical wiring work not listed above or specified herein or on drawings to be done as part of electrical work is to be installed in conduit and is to be done as part of mechanical work in accordance with wiring requirements specified for electrical work.

3.20 INTERRUPTION TO AND SHUT-DOWN OF MECHANICAL SERVICES AND SYSTEMS

- .1 Coordinate shut-down and interruption to existing mechanical systems with Owner. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein this Article. Services for operation of existing non-renovated areas of building are to be maintained.
- .2 Upon award of a Contract, submit a list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform Owner and Consultant in writing 5 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent. Shutdowns of some essential services may require additional advance notification time.
- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.
- .5 Pipe freezing may be used to connect new piping to existing piping without draining existing piping. Pipe freeze equipment is to be equal to "NORDIC FREEZE" equipment supplied by Mag Tool Inc. (1-800-661-9983) or Rigid Tool Co. RIGID "SuperFreeze".

3.21 EQUIPMENT BASES AND SUPPORTS

- .1 Unless otherwise specified or required, set floor mounted equipment on minimum 100 mm (4") high reinforced concrete housekeeping pads 200 mm (8") clear of equipment on each side and end, or a minimum of 200 mm (8") from centreline of equipment anchor bolts to edge of the base, whichever is larger. Conform to following requirements:
 - .1 supply dimensioned drawings and equipment base templates, and provide anchor bolts for proper setting and securing of equipment on pads;
 - .2 place anchor bolts during concrete pour and be responsible for required levelling, alignment, and grouting of equipment;
 - .3 as a minimum, use wire mesh reinforcement, however, for pads for large heavy equipment, use reinforcement as per structural drawing details.
- .2 For equipment not designed for base mounting, where required, provide welded, cleaned and prime coat painted structural steel stands or supports conforming to following requirements:
 - .1 provide stands and supports, except those for small equipment, designed by a structural engineer registered in jurisdiction of the work, and submit stamped and signed design drawings with calculations as shop drawings for review;
 - .2 flange bolt steel stands to concrete housekeeping pads;
 - .3 seismically restrained stands and supports in accordance with applicable requirements.

3.22 CONCRETE WORK FOR MECHANICAL EQUIPMENT BASES/PADS

- .1 Provide poured concrete work, including reinforcing and formwork, required for mechanical equipment bases/pads. Perform concrete work in accordance with requirements specified in Division 03.
- .2 Concrete is to be minimum 20,700 kPa ready-mix concrete in accordance with CAN/CSA-A23.1 and the Building Code.
- .3 Submit for review, dimensioned shop drawings, prepared and stamped by a professional structural engineer registered in the jurisdiction of the work, for concrete pads or bases for support of large, heavy equipment. Indicate on shop drawings total weight of pad or base as well as equipment it is provided for, and concrete reinforcing.

3.23 EXCAVATION AND BACKFILL WORK

- .1 Before commencement of excavation for work, determine in consultation with Consultant, Owner, Municipality and utilities, presence, if any, of existing underground services at site. Engage local utilities to locate and mark out such services. Ensure trades concerned are aware of their presence.
- .2 Be responsible for any damage done to underground services caused by neglect to determine and mark out location of such services prior to excavation work commences.
- .3 Where Work falls under jurisdiction of local governing utility, confirm requirements and comply with utility requirements.

- .4 Provide excavation, backfill and related work required for mechanical work. Perform such work in accordance with requirements of the Excavation and Backfill work Section, except as modified by this Article. Obtain a copy of soil test report if available from Consultant. Depth of excavations must accommodate local governing requirements and local standard practices to compensate for local frost levels of Place of the Work.
- .5 Inverts and locations of existing site services may have been site surveyed and approximate location may be shown on drawings. Confirm inverts and locations are correct, prior to commencing excavation and contact Utilities to accurately locate their services. Where discrepancies are found, immediately inform Consultant, and await a direction. Grade bottom of trench excavations as required.
- .6 In firm, undisturbed soil, lay pipes directly on soil, unless otherwise directed.
- .7 Before backfilling, arrange for inspection of work by Consultant. Do not backfill work unless reviewed with Consultant. Failure to do so prior to backfilling will require re-excavating work and re-backfill at no additional cost to Owner.
- .8 Unless otherwise specified, backfill trenches within building with clean sharp sand in individual layers of maximum 150 mm (6") thickness compacted to a density of 100% Standard Proctor. Hand compact first layers up to a compacted level of minimum 300 mm (12") above top of pipe. Hand or machine compact the balance up to grade.
- .9 Unless otherwise specified, backfill trenches outside the building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18") thick above the pipe, hand compacted to a density of 95% Standard Proctor, using granular "A" gravel. Backfill the balance in 150 mm (6") layers with approved excavated material, compacted to 95% Standard Proctor density.
- .10 Unless otherwise specified, backfill trenches outside building under roads, parking lots or traffic areas with crushed stone or granular "A" gravel in layers not exceeding 150 mm (6") thickness, compacted to 100% Standard Proctor density up to grade level.
- .11 Provide minimum 1.37 m (4.5') of cover for underground piping subject to freezing and located outside building.
- .12 Provide minimum 450 mm (18") of cover for underground piping subject to freezing and located inside building.
- .13 After first lift of backfill has been compacted, mark entire path of pipe using continuous 75 mm (3") wide detectable identified marking tape equal to SMS Ltd. D-UGMT.
- .14 Unless otherwise directed in Division 02 and/or 31, store and dispose of excavated materials as follows:
 - .1 during progress of contract, place material as directed in such a manner to minimize damage or disfigurement of ground and which in no way impedes progress of work;
 - .2 separately place surplus topsoil and subsoil as directed; leave site clean and unencumbered.
- .15 Perform pumping as required to keep excavations free of water.

- .16 Engage services of independent soils testing agency to test final backfill compaction density of each backfilled location. Compact backfill to satisfaction of testing agency and in accordance with Specification. Submit a copy of testing agency's report to Consultant for review.
- .17 Fill depressions to correct grade level with appropriate material, after an adequate period has passed to reveal any settlement. Use maximum possible compaction. Pay costs required to make good damages caused by settlement.
- .18 Coordinate requirements for final surface toppings (concrete, asphalt, pavers, grass sod, etc.) with General Contractor.

3.24 CUTTING, PATCHING AND CORE DRILLING

- .1 Unless otherwise provided by General Trades, perform cutting, patching, and core drilling of existing building required for installation of mechanical work. Perform cutting in a neat and true fashion, with proper tools and equipment to Consultant's approval. Patching is to exactly match existing finishes and be performed by tradesmen skilled in particular trade or application. Work is subject to review and acceptance by Consultant.
- .2 Criteria for cutting holes for additional services:
 - .1 cut holes through slabs only; no holes to be cut through beams;
 - .2 cut holes 150 mm (6") diameter or smaller only; obtain approval from Structural Consultant for larger holes;
 - .3 keep at least 100 mm (4") clear from beam faces;
 - .4 space at least 3 hole diameters on centre;
 - .5 for holes that are required closer than 25% of slab span from supporting beam face, use cover meter above slab to clear slab top bars;
 - .6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;
 - .7 submit sleeving drawings indicating holes and their locations for Structural Consultant's review.
- .3 Do not cut or drill any existing work without approval from Owner and Consultant. Be responsible for damage done to building and services caused by cutting or drilling.
- .4 Where pipes pass through existing construction, core drill an opening. Size openings to leave 12 mm (½") clearance around pipes or pipe insulation.
- .5 Prior to drilling or cutting an opening, determine, in consultation with Consultant and Owner, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any existing services and reinforcement bars concealed behind building surface to be cut and locate openings to suit. Coring is not permitted through concrete beams or girders.

- .6 Where drilling is required in waterproof slabs, size opening to permit snug and tight installation of a pipe sleeve sized to leave 12 mm (½") clearance around pipe or pipe insulation. Provide a pipe sleeve, constructed of Schedule 40 galvanized steel pipe with a flange at one end and of a length to extend 100 mm (4") above slab, in opening. Secure flange to the underside of slab and caulk void between sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water-tight installation.
- .7 Firestop and seal openings in fire rated construction in accordance with requirements of article entitled Firestopping and Smoke Seal Materials in this Section. Do not leave openings open overnight unless approved by Owner and Consultant.

3.25 PACKING AND SEALING CORE DRILLED PIPE OPENINGS

- .1 Pack and seal void between pipe opening and pipe or pipe insulation for length of opening as follows:
 - .1 non-fire rated interior construction – pack with mineral wool and seal both ends of opening with non-hardening silicone base caulking compound to produce a water-tight seal;
 - .2 exterior walls above grade – pack with mineral wool and seal both ends of sleeves water-tight with non-hardening silicone base caulking compound unless mechanical type seals have been specified;
 - .3 exterior walls below grade (and any other wall where water leakage may be a problem) – seal with link type mechanical seals as specified.

3.26 FLASHING FOR MECHANICAL WORK PENETRATING ROOF

- .1 Perform required flashing work, including counter-flashing, for mechanical work penetrating and/or set in roof.
- .2 Perform flashing work in accordance with requirements of drawing details, and requirements specified in Division 07.

3.27 CLEANING MECHANICAL WORK

- .1 Clean mechanical work prior to application for Substantial Performance of the Work.
- .2 Include for vacuum cleaning interior of air handling units and ductwork systems.

3.28 CONNECTIONS TO OTHER EQUIPMENT

- .1 Carefully examine Contract Documents during bidding period and include for mechanical work piping and/or ductwork connections to equipment requiring such connections.

3.29 INSTALLATION OF FLEXIBLE CONNECTORS

- .1 Provide flexible connectors in piping connections to seismically restrained equipment, and wherever else shown.
- .2 Provide flexible connectors in piping connections to vibration isolated equipment.

3.30 FAN NOISE LEVELS

- .1 Submit sound power levels with fan shop drawings/product data, with levels measured to AMCA 300 and calculated to AMCA 301.

3.31 EQUIPMENT AND SYSTEM MANUFACTURER'S CERTIFICATION

- .1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for equipment/system manufacturer's authorized representative to visit site to examine installation, and after any required corrective measures have been made, to certify in writing to Consultant that equipment/system installation is complete and in accordance with equipment/system manufacturer's instructions.

3.32 EQUIPMENT AND SYSTEM START-UP

- .1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in mechanical work Sections in accordance with following requirements:
 - .1 submit a copy of each equipment/system manufacturer's start-up report sheet to Consultant for review, and incorporate any comments made by Consultant;
 - .2 under direct on-site supervision and involvement of equipment/system manufacturer's representative, start-up equipment/systems, make any required adjustments, document procedures, leave equipment/systems in proper operating condition, and submit to Consultant complete set of start-up documentation sheets signed by manufacturer/supplier and Contractor.

END OF SECTION

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies seismic control and restraint requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.02 SEISMIC CONSULTANT

- .1 Retain and pay for services of an experienced Seismic Consultant who is a registered professional engineer licensed in the jurisdiction of the work and a member in good standing of a Professional Engineers Association in the jurisdiction of the work.
- .2 Seismic Consultant is to:
 - .1 determine proper seismic hazard level, design, recommend, and review proposed mechanical work seismic restraint shop, placement and securing drawings, and sign and stamp drawings prior to submittal for review as specified below;
 - .2 supervise installation of mechanical work seismic restraint and, when work is complete, certify in writing that seismic restraint work has been installed in accordance with signed, stamped and reviewed drawings;
 - .3 prepare and submit to Municipality and authorities having jurisdiction, on a form approved by Municipality and authorities having jurisdiction, at the beginning of seismic restraint work and when work is complete, original signed and sealed Letters of Assurance for design, installation and field review of seismic restraint work.

1.03 SUBMITTALS

- .1 Obtain required equipment information and submit manufacturer's shop drawings/product data sheets for restraining devices and steel bases. Include placement data, and details of attachment to both equipment and structure meeting requirements of forces involved. Product data sheets and drawings are to be signed and stamped by Seismic Consultant referred to above.
- .2 Submit copies of Seismic Consultant's Letters of Assurance as specified above.
- .3 Submit copies of Seismic Consultant and seismic control manufacturer's certification letters as specified in Part 3 of this Section.
- .4 If requested, submit samples of seismic restraint materials for review.

1.04 QUALITY ASSURANCE

- .1 Seismic restraints are to be designed by a registered professional engineer as specified above, and are to be installed by qualified tradesmen under supervision of and to the approval of the design engineer.
- .2 Unless otherwise specified, seismic control and restraints are to be designed in accordance with Code requirements, ANSI/SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, SMACNA/ASHRAE Service Restraint Applications CD-ROM, and the P.P.I.C. Manual Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems, all of which are to form a part of this Section.
- .3 Seismic control and restraints for fire protection piping and equipment are to be in accordance with NFPA requirements. When specified and/or required, design is also to include Factory Mutual requirements.
- .4 Restraint products must be tested in an independent testing laboratory, or certified by Seismic Consultant, to confirm restraint products meet requirements of this Section, i.e. dynamic ultimate limit load state as required by Code, "Fail Safe" design, etc. If particular tests are carried out to represent a restraint type, test is to be valid for the full load range of the restraint. Submit such tests or certification when requested.
- .5 Seismic control and restraint product manufacturers are to provide required assistance during installation, and, when installation is complete, submit written reports listing any deficiencies to the installation.

2 PRODUCTS

2.01 GENERAL

- .1 Isolation, anchors, bolts, bases, restraints, etc., are to be designed to withstand without failure or yielding, the dynamic G load as specified in Code for the seismic zone in which building is located. Design loads are ultimate limit state loads (1.5 times working load) acting through the centre of gravity of the anchored or restrained equipment. "Fail Safe" designs are acceptable.
- .2 For both isolated and non-isolated floor mounted equipment, i.e. tanks, heat exchangers, boilers, etc., design and provide anchors and bolts to withstand, without failure or yielding, a dynamic ultimate limit state load as defined in Code, of the greater of 0.3 g or as required by Code, applied horizontally through the centre of gravity.
- .3 Where impact forces may be significant, use ductile materials.
- .4 Seismic restraining devices factory supplied with equipment are to meet requirements of this Section.
- .5 Acceptable manufacturers are:
 - .1 Mason Industries Inc.;
 - .2 Kinetics Noise Control;
 - .3 Vibro-Acoustics Ltd;
 - .4 Price Industries Inc.

2.02 SLACK CABLE RESTRAINTS

- .1 Aircraft cable galvanized slack cable restraints meeting current requirements of Building Code, sized to suit the application and complete with required cable ties, anchor hardware (selected for a load equal to twice the weight of the equipment), and similar connection accessories.

2.03 ANCHOR BOLTS

- .1 Equal to Mason Industries type SAB seismic anchor bolts.

2.04 FLEXIBLE PIPING CONNECTIONS

- .1 Flexible piping connectors are to be supplied with seismic restraint materials. Where flexible connections are not specified with piping in other Sections they are to be equal to Mason Industries twin sphere, non-metallic connectors with hose lengths preset in strict accordance with manufacturer's instructions and to approval of Seismic Consultant, each rated for continuous operation at 1725 kPa at 87.7°C (250 psi at 190°F) or 1380 kPa at 121°C (200 psi at 250°F), and complete with:
 - .1 nylon tire cord reinforced EPDM body;
 - .2 ductile iron reinforcing ring and ductile iron screwed or flanged connections as required and to suit piping system operating pressure.

2.05 VIBRATION ISOLATION PRODUCTS

- .1 Refer to Section entitled Mechanical Vibration Control.

3 EXECUTION

3.01 INSTALLATION OF SEISMIC RESTRAINT MATERIALS

- .1 Provide seismic restraint for mechanical equipment, piping, and ductwork, including diffusers, grilles, etc., as per requirements of current edition of Building Code and this Section of the Specification.
- .2 Following Mechanical Components Restraint Guide is to be used as a general guide only to establish appropriate restraint methods, hardware, and attachments, however, due to differences in construction, size, weight, and configuration of different manufacturer's equipment and variety of ways and means that equipment and components can be installed, specific restraint methods are to be confirmed in the field. Seismic restraint materials and methods are to be reviewed and approved by Seismic Consultant.

MECHANICAL COMPONENT RESTRAINT GUIDE

ITEM	TYPE OF RESTRAINT	MINIMUM NO. OF RESTRAINTS	NOTES
In-line Pumps	SCR	2	Pipe mounted type pump
Pumps Non-Isolated	BTHP	4	Base mount type pump
Pumps Isolated	SNBR	4	Base mount type pump
Expansion Tanks	SCR	4	
D.H.W. Tanks	SCR	4	Attach to removable steel strap yoke
Glycol Tanks	SCR	4	Attach to removable steel strap yoke
Heat Exchangers	BTHP	4	Bolt to custom support frame
Radiant Panels	SCR	4	Per panel section
Unit Heaters	TSR-SCR	4	
AHU's and A/C Units Free Standing			
- With Base	BTHP	4	
- Without base	CSSB	4	
AHU's and A/C Units Suspended			
- Isolated	SCR	4	
- Non-Isolated	SCR	4	
Packaged Rooftop Air Units (all types)			
On roof curb	BTRC	4	Roof curb bolted to roof.
Fans – Suspended			
- Isolated	SCR	4	
- Non-Isolated	SCR	4	
Fans – Freestanding			
- Isolated	SNBR	4	
- Non-Isolated	BTHP	4	
Grilles, Registers, Diffusers	SCR	4	Where not bolted to duct (in T-bar ceilings)
Piping	SCR TSR	As required	As per Specification

ITEM	TYPE OF RESTRAINT	MINIMUM NO. OF RESTRAINTS	NOTES
Ductwork	SCR TSR	As required	As per Specification

LEGEND	
SCR	Slack cable restraint (bolted to structure)
SNBR	Seismic snubber (bolted to structure)
TSR	Threaded support rod (bolted or clamped to structure)
BTSLPR	Bolt to sleeper (sleeper bolted to structure)
BTHP	Bolt to concrete housekeeping pad (pad to be keyed to structure)
CSSB	Custom steel shoe base (bolted to structure)
BTRC	Bolt to roof curb (roof curb bolted to roof structure)

- .3 Provide structural steel bases for equipment unless equipment manufacturer certifies direct attachment capabilities.
- .4 Space restraints under equipment so minimum distance between adjacent corner restraints is at least equal to the height of the centre of gravity of the equipment. Include the height of the centre of gravity on shop drawings, otherwise, design for increased forces on supports and submit design calculations with shop drawings. In particular, chillers are to meet this requirement.
- .5 Floor mounted isolated equipment is to be installed on 100 mm (4") high concrete housekeeping pads with at least 200 mm (8") clearance between drilled inserts and edges of pads. Ensure housekeeping pads are keyed to structure to resist seismic displacement.
- .6 Requirements pertaining to seismic control work are as follows:
 - .1 execute seismic control and restraint work in accordance with drawing details, reviewed shop drawings, ANSI/SMACNA Seismic Restraint Manual, PIPC Manual: Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems, and National Uniform Seismic Installation Guidelines (NUSIG);
 - .2 seismic control systems are to work in all directions;
 - .3 fasteners and attachment points are to resist same maximum load as the seismic restraint;
 - .4 drilled or power driven anchors and fasteners are not permitted;
 - .5 no equipment, equipment supports or mounts are to fail before failure of structure;
 - .6 supports of cast iron or threaded pipe are not permitted;
 - .7 seismic control measures are not to interfere with integrity of firestopping;

- .8 equipment is to be bolted to structure, and bolts are to be fitted with isolation washers;
 - .9 number, size, type, and installation of anchor bolts are to be as recommended by anchor bolt manufacturer and seismic design consultant;
 - .10 where more than a 3 mm (1/8") differential exists between an anchor or attachment bolt diameter, an anchor and attachment point hole, or an isolator gap attachment bolt and equipment anchor attachment hole, pack air gap with Mason type 0.5 FastSteel reinforced epoxy putty;
 - .11 hung equipment and pipe hangers are to be fitted with a means of preventing upward movement, and non-isolated equipment and pipe hanger rods are to be fitted with oversized steel washers and nuts above and below hanger or equipment attachment point, locked tight to prevent uplift of equipment or hanger;
 - .12 where suspended equipment hanger rod length exceeds 50 rod diameters between structure and equipment attachment point, reinforce rods with angle iron to prevent bending due to uplift forces;
 - .13 seismic control measures are not to jeopardize noise and vibration isolation systems, and 6 mm (1/4") to 9 mm (3/8") clearance during normal operation of equipment and systems is to be provided between seismic restraint and equipment;
 - .14 where hold-down bolts for seismic restraint equipment penetrate roofing membranes coordinate with roofing trade for installation of pitch pockets/"gum cups" and sealing compound to maintain water-tight integrity of roof;
 - .15 where friction type clamps are used for support of equipment and connecting services, secure clamps to steel work by means of welding or other positive means to prevent slippage or loosening of clamps due to seismic forces.
- .7 Provide slack cable restraint assemblies for:
- .1 compressed air and service piping 25 mm (1") dia. and larger;
 - .2 piping 32 mm (1-1/4") dia. and larger located in boiler, fan, chiller, and similar equipment rooms;
 - .3 horizontal and vertical piping 65 mm (2-1/2") dia. and larger;
 - .4 ductwork and duct mounted equipment;
 - .5 isolated and non-isolated ceiling hung fans, tanks, equipment, etc.
- .8 Installation requirements for slack cable restraints include following:
- .1 connect slack cable restraints to ceiling hung equipment in such a way that axial projection of wires passes through the centre of gravity of the equipment;
 - .2 orient restraint wires on ceiling hung equipment at approximately 90° to each other (in plan), and tie back to the ceiling slab at an angle not exceeding 45° to slab;

- .3 install cables using appropriate grommets, shackles, and other hardware to ensure alignment of restraints and to avoid bending cables at connection points, and, where feasible, wrap cables directly around pipes as opposed to using collars;
- .4 for piping systems, provide transverse slack cable restraints at a maximum spacing of 12.5 m (40'), and longitudinal restraints at 25 m (80') maximum spacing, or as limited by anchor/slack cable performance;
- .5 for piping less than 250 mm (10") dia., reduce transverse restraint spacing to 6 m (20'), and note that smaller piping may be rigidly tied to larger piping for restraint, but not the reverse;
- .6 vary adjacent spacing of restraints on a piping run by 10% to 30% to avoid coincident resonance;
- .7 transverse bracing for one pipe section may also act as longitudinal bracing for piping connected perpendicular to it if bracing is installed within 600 mm (24") of elbow or tee, and if connected piping is same or smaller dia., and note that branch lines are not to be used to restrain main lines;
- .8 provide flexibility in piping joints or sleeves where piping penetrates building seismic or expansion joints;
- .9 wherever possible, support weight of vertical piping risers at a point or points above the centre of gravity of riser, and provide lateral guides at top and bottom of riser, and at intermediate points not to exceed the transverse spacing specified above for horizontal pipes, with guide clearance not exceeding 3 m (10');
- .10 install restraints at least 50 mm (2") clear of other equipment and services;
- .11 adjust restraint cables such that they are not visibly slack, or such that flexibility is approximately 40 mm (1-½") under thumb pressure for a 1.5 m (5') cable length, with an equivalent ratio for other cable lengths, and adjust clearance of cable strap/spacer piece restraints so as not to exceed 6 mm (0.23");
- .12 provide transverse and axial restraints within 4 m (12') of a vertical bend;
- .13 at steel trusses, connect to top chords at panel points and follow truss manufacturer's instructions;
- .14 diffusers and grilles mounted in t-bar ceilings or which are not positively secured to ductwork or structure are to be fitted with slack cable restraints to prevent them from falling in the event the ceiling t-bar grid is displaced;
- .15 do not bridge vibration isolators with slack cable restraints;
- .16 other approved restraint systems are conventional pipe guides, rigid restraint where piping passes through a block or concrete wall, or a cable strap and spacer piece attached to structure and used where piping is adjacent to a wall and conventional slack cable restraints cannot be used.

3.02 INSTALLATION OF FLEXIBLE PIPING CONNECTORS

- .1 Supply flexible piping connectors for connections (including plumbing) to seismically restrained equipment. Hand connectors to appropriate piping trade at site for installation.

3.03 SITE INSPECTION AND LETTERS OF CERTIFICATION

- .1 When seismic control products have been installed, arrange for seismic control product manufacturer and Seismic Consultant to examine installation of seismic control products and to certify in writing (separate letters) that products have been properly installed in accordance with governing Codes and Regulations, and recommendations and instructions. Seismic Consultant is to apply his professional stamp to the letter.

END OF SECTION

1.01 GENERAL

1.02 APPLICATION

- .1 This Section specifies vibration isolation product requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.03 SUBMITTALS

- .1 Submit copies of manufacturer's product data sheets for products specified in this Section. Product data sheets are to include product characteristics, limitations, dimensions, finishes, and installation recommendations.
- .2 Submit a letter from vibration isolation manufacturer to certify correct installation of products, as specified in Part 3 of this Section.

2. PRODUCTS

2.01 GENERAL

- .1 Vibration isolation products are to be in accordance with drawing schedule and details, and as specified below.
- .2 Springs are to be stable, colour coded, selected to operate at no greater than $\frac{2}{3}$ solid load, designed in accordance with Society of Automotive Engineers Handbook Supplement 9 entitled Manual on Design and Application of Helical and Spiral Springs, and with spring diameters in accordance with manufacturer's recommendations to suit static deflection and maximum equipment load.
- .3 Steel components of isolation products not exposed to the weather or moisture are to be zinc plated. Steel components of isolation products exposed to the weather or in a damp, moist environment are to be factory painted with rust inhibiting primer and 2 coats of neoprene.
- .4 Where weight of isolated equipment may change significantly due to draining or filling with a liquid, vibration isolators are to be equipped with limit stops to limit spring extensions.
- .5 Flexible piping connections to vibration isolated equipment are specified in the appropriate piping sections of the Specification.

2.02 ACCEPTABLE MANUFACTURERS

- .1 Below are the acceptable manufactures for mechanical vibration control products:
 - .1 Vibro-Acoustics Ltd.;
 - .2 The VMC Group Vibration Mounting & Controls Inc. (Korfund-Dynamics);
 - .3 Kinetics Noise Control Vibron Products Group;
 - .4 Mason Industries Inc.;
 - .5 Isotech Industries Inc.

2.03 ISOLATION PADS

- .1 Sandwich type pads, 20 mm ($\frac{3}{4}$ ") nominal thickness, selected for 3.2 mm ($\frac{1}{8}$ ") static deflection unless otherwise specified, consisting of 2 waffle type or ribbed 50 durometer neoprene pads permanently bonded to a minimum #10 gauge steel plate, and complete with rubber bushed bolt holes and equipment anchor bolts with neoprene isolation grommets.

2.04 RUBBER FLOOR ISOLATORS

- .1 Captive, bridge bearing quality neoprene mount selected for a minimum 4 mm (0.15") static deflection unless otherwise specified, with an integral ductile iron housing and integral equipment anchor bolt.

2.05 SPRING FLOOR ISOLATORS

- .1 Seismically rated captive spring mount isolator complete with levelling bolts, upper and lower neoprene spring cups, neoprene cushion, ductile iron housing, neoprene sound pads, and neoprene isolation grommets for securing bolts.

2.06 OPEN SPRING MOUNTS

- .1 Base mount free-standing assemblies, each complete with a stable colour coded steel spring welded in place, drilled mild steel mounting plate bonded to a ribbed rubber or neoprene acoustical pad, and an external 16 mm ($\frac{5}{8}$ ") diameter level adjustment bolt.

2.07 CLOSED SPRING MOUNTS

- .1 Base mount free-standing enclosed assemblies, each complete with stable colour coded spring(s), 2 piece cast housing, non-binding rubber horizontal stabilizers, a ribbed rubber or neoprene acoustical pad bonded to base of the closed housing, and an external level adjustment bolt.

2.08 TOTALLY RETAINED SPRING MOUNTS

- .1 Base mount free-standing enclosed and retained assemblies to limit both vertical and lateral movement of mounted equipment, each complete with stable colour coded spring(s), drilled welded steel housing and top plate, ribbed rubber or neoprene acoustical pad bonded to bottom of housing, vertical limit adjusting hardware, and a level adjustment bolt.

2.09 SPRING HANGERS

- .1 Welded steel plate housing with top and bottom rod mounting holes and spring retainer, neoprene double deflection isolation element, stable colour coded spring, and heavy-duty rubber washers.

2.10 NEOPRENE HANGER ISOLATORS

- .1 Neoprene double deflection rod isolators with steel housing and hanger rod bushing, selected for a minimum 4 mm (0.15") static deflection unless otherwise specified.

2.11 STEEL EQUIPMENT BASE

- .1 Fully welded structural steel equipment and motor support bases, each complete with a wide flange steel frame, full depth cross members, brackets for spring mounts, and adjustable motor slide rails.

3. EXECUTION

3.01 INSTALLATION OF VIBRATION ISOLATION MATERIALS

- .1 Provide vibration isolation products for mechanical work in accordance with drawing schedule and details, and requirements specified herein and/or on drawings.
- .2 Supply to vibration isolation product manufacturer or supplier a copy of a "reviewed" shop drawing or product data sheet for each piece of equipment to be isolated and dimensioned pipe layouts of associated piping to be isolated.
- .3 Unless otherwise specified, vibration isolation products are to be product of one manufacturer.
- .4 Ensure vibration isolation manufacturer coordinates material selections with equipment provided in order to ensure adherence to performance criteria. Allow for expansion and contraction when material is selected and installed.
- .5 Unless otherwise indicated, install isolation materials for base mounted equipment on concrete housekeeping pad bases which extend at least over the full base and isolated area of the isolated equipment. Additional requirements are as follows:
 - .1 block and shim bases level so ductwork and piping connections can be made to a rigid system at proper operating level, before isolated adjustment is made, and ensure there is no physical contact between isolated equipment and building structure;
 - .2 steel bases are to clear the sub-base by 25 mm (1");
 - .3 concrete bases are to clear the sub-base by 50 mm (2").
- .6 Isolate piping larger than 25 mm (1") dia. directly connected to motorized and/or vibration isolated equipment with 25 mm (1") static deflection spring hangers at spacing intervals in accordance with following:
 - .1 for pipe less than or equal to 100 mm (4") dia. – first 3 points of support;
 - .2 for pipe 125 mm (5") to 200 mm (8") dia. – first 4 points of support;
 - .3 for pipe equal to or greater than 250 mm (10") dia. – first 6 points of support;
- .7 First point of isolated piping support is to have a static deflection of twice the deflection of the isolated equipment but maximum 50 mm (2").
- .8 Secure top of spring hanger frame rigidly to structure, and do not install spring hangers in concealed locations.

- .9 Where it is impossible to use at least 2 spring hangers, provide Senior Flexonics Ltd. Style 102 (or 102-U as required) or equal, twin sphere, moulded rubber flexible connection assemblies, selected by manufacturer and suitable in all respects for intended application, and complete with required nipples and connections to provide proper vibration isolation.
- .10 Isolate designated piping risers at floor support points in accordance with drawing detail.
- .11 For control wiring connections to vibration isolated equipment ensure flexible metallic conduit with 90° bend is used for conduit 25 mm (1") dia. and smaller, and for conduit larger than 25 mm (1") dia., use Crouse Hinds EC couplings. Connections are to be long enough so that conduit will remain intact if equipment moves 300 mm (12") laterally from its installed position, and flexible enough to transmit less vibration to structure than is transmitted through vibration isolation. Coordinate these requirements with mechanical trades involved. If electrical power connections are not made in a similar manner as part of the electrical work, report this fact to Consultant.
- .12 Arrange and pay for vibration isolation product manufacturer to visit site to inspect installation of his equipment. Perform revision work required as a result of improper installation. When vibration isolation equipment manufacturer is satisfied with the installation, obtain and submit a letter stating manufacturer has inspected the installation and equipment is properly installed.
- .13 Refer to Section entitled Seismic Control and Restraint for requirements pertaining to seismically restrained vibration isolation.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies insulation requirements common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly.

1.2 DEFINITIONS

- .1 "concealed" – means mechanical services and equipment above suspended ceilings, in non-accessible chases, in accessible pipe spaces, and furred-in spaces.
- .2 "exposed" – means exposed to normal view during normal conditions and operations.
- .3 "mineral fibre" – includes glass fibre, rock wool, and slag wool.
- .4 "domestic water" or "potable water" – means piping extended from building Municipal supply main.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the mechanical insulation work is specified in other Sections of the Specification:
 - .1 plumbing and drainage piping and equipment;
 - .2 hydronic piping and/or equipment;

1.4 SUBMITTALS

- .1 Submit a product data sheet for each insulation system product.

1.5 SAMPLES

- .1 Submit to the Consultant for review, a sample of each type of insulation, in applied form. Mount the samples on a rigid plywood board. Identify each sample with the manufacturer's name and insulation type, and the proposed use of the insulation. The sample board shall be provided in shop drawing form. Accompanying the sample board shall be complete, up to date literature from the manufacturer for each product. It shall be understood that any and all insulation supplied and/or installed on the project shall be in accordance with the reviewed sample board.

1.6 QUALITY ASSURANCE

- .1 Mechanical insulation is to be applied by a licensed journeyman insulation mechanic, or by an apprentice under direct, daily, on-site supervision of a journeyman mechanic.
- .2 Do not apply insulation unless leakage tests have been satisfactorily completed.
- .3 Ensure surfaces to be insulated are clean and dry.
- .4 Ensure ambient temperature is minimum 13°C (55°F) for at least 1 day prior to application of insulation, and for duration of insulation work, and relative humidity is and will be at a level such that mildew will not form on insulation materials.
- .5 Company with sub-contract for mechanical insulation work is to be a member in good standing of Thermal Insulation Association of Canada.
- .6 Insulation materials must be stored on site in a proper and dry storage area. Any wet insulation material is to be removed from site.

1.7 VAPOUR BARRIER JACKET

- .1 Insulation specified with a vapour jacket, shall be supplied with the vapour barrier jacket factory installed. Installation of a vapour barrier jacket outside of the insulation manufacturer's factory is not acceptable and will be considered deficient work. Contractor and manufacturer shall certify in writing that vapour barrier jacketed insulation supplied and installed on the work is in accordance with this stipulation.

2. Products

2.1 FIRE HAZARD RATINGS

- .1 All insulation system materials must meet requirements of NFPA 90A and insulation system materials inside building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.

2.2 THERMAL PERFORMANCE

- .1 Unless otherwise specified, thermal performance of insulation is to meet or exceed values given in Tables entitled Minimum Piping Insulation Thickness Heating and Hot Water Systems and Minimum Piping Insulation Thickness Cooling Systems, as stated in ANSI/ASHRAE/IES Standard 90.1 version referenced in Ontario Building Code.

2.3 PIPE INSULATION MATERIALS

- .1 Horizontal pipe insulation at hangers and supports are to be equal to Belform Insulation Ltd. "Koolphen K-Block" insulated pipe support inserts consisting of minimum 150 mm (6") long, pre-moulded, rigid, sectional phenolic foam insulation (of same thickness as adjoining insulation) with a reinforced foil and kraft paper vapour barrier jacket and a captive galvanized steel saddle.
- .2 Fire rated pre-moulded mineral wool is to be non-combustible, fire-rated, rigid, sectional, longitudinally split mineral wool or basalt pipe insulation with a reinforced vapour barrier jacket and compatible with ULC S115 and ULC-S101 firestopping. Acceptable products are:
 - .1 Roxul "Tecton 1200";
 - .2 IIG (Johns Manville Inc.) MinWool-1200;
 - .3 Paroc 1200.
- .3 Pre-moulded mineral fibre is to be rigid, sectional, sleeve type insulation to ASTM C547, with a factory applied vapour barrier jacket. Acceptable products are:
 - .1 Johns Manville Inc. "Micro-Lok AP-T Plus";
 - .2 Knauf Fiber Glass "Pipe Insulation" with "ASJ-SSL" jacket;
 - .3 Manson Insulation Inc. "ALLEY K APT";
 - .4 Owens Corning "Fiberglas" Pipe Insulation.
- .4 Blanket mineral fibre is to be blanket type roll insulation to CGSB 51-GP-11M, 24 kg/m³ (1-½ lb/ft³) density, with a factory applied vapour barrier facing. Acceptable products are:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .5 Pre-moulded weatherproof jacketed mineral fibre is to be Knauf Insulation "Redi-Klad 1000" sectional, sleeve type pipe insulation with a self-sealing weather-proof jacket and a 100 mm (4") butt joint sealing strip with each section.

2.4 BARRIER-FREE LAVATORY PIPING INSULATION KITS

- .1 Removable, flexible, reusable, white moulded plastic insulation kits for barrier-free lavatory drain piping and potable water supplies exposed under lavatory.
- .2 Acceptable products are:
 - .1 Truebo "Lav-Guard 2" E-Z Series;
 - .2 Zeston "SNAP-TRAP";
 - .3 McGuire Manufacturing Co. Inc. "ProWrap".

2.5 PIPE INSULATION REQUIREMENTS – FLEXIBLE FOAM ELASTOMERIC

- .1 Install flexible elastomeric pipe insulation in strict accordance with manufacturer's published instructions to suit the application, and using adhesive, joint sealants and finish to produce a water-tight installation. Insulate following pipe with flexible elastomeric pipe insulation of thickness indicated:

2.6 EQUIPMENT INSULATION MATERIALS

- .1 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m³ (1-½ lb/ft³) density, with a factory applied vapour barrier facing. Acceptable products are:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .2 Semi-rigid mineral fibre board is to be roll form, moulded insulation to ASTM C1393, with a factory applied vapour barrier facing consisting of laminated aluminum foil and kraft paper. Acceptable products are:
 - .1 Knauf Fiber Glass Pipe and Tank Insulation;
 - .2 Manson Insulation Inc. "AK FLEX";
 - .3 Johns Manville Inc. Pipe and Tank Insulation "Micro-Flex";
 - .4 Multi-Glass Insulation Ltd. "MULTI-FLEX MF";
 - .5 Owens Corning Pipe and Tank Insulation;
 - .6 Glass-Cell Fabricators Ltd. "R-Flex".

2.7 REMOVABLE/REUSABLE INSULATION COVERS

- .1 Valve, etc. covers are to be NO SWEAT reusable insulation wraps with vapour barrier jacket and self-sealing ends and longitudinal seam, with a length to suit the application and an insulation thickness equal to adjoining insulation.
- .2 Custom manufactured equipment covers conforming to shape of item to be insulated, designed to be easily removable and replaceable to suit use and maintenance procedures of particular item, and to provide adequate personnel protection. Covers are to be complete with minimum 95 kg/m³ (6 lb/ft³) density ceramic fibre insulation sewn between minimum 542.5 g/m² (1.8 oz/ft²) weight silicone impregnated fibreglass fabric in a quilted pattern using double stitches made with Kelvar or Teflon coated fibreglass thread. Overlap flaps are to be secured using laces, snaps, or Velcro double stitched in place. Acceptable manufacturers are:
 - .1 Crossby Dewar Inc.;
 - .2 Insufab Systems Inc.;
 - .3 ADL Insulflex Inc.;
 - .4 Firwin Corp.;
 - .5 GlassCell Isofab Inc.

2.8 DUCTWORK SYSTEM INSULATION MATERIALS

- .1 Rigid mineral fibre board is to be pre-formed board type insulation to ASTM C612, 48 kg/m³ (3 lb/ft³) density, with a factory applied reinforced aluminum foil and kraft paper facing. Acceptable products are:
 - .1 Knauf Fiber Glass Insulation Board with FSK facing;
 - .2 Manson Insulation Inc. "AK BOARD FSK";
 - .3 Johns Manville Inc. Type 814 "Spin-Glas";
 - .4 Owens Corning 703.
- .2 Semi-rigid mineral fibre board is to be roll form insulation to ASTM C1393, consisting of cut strips of rigid mineral board insulation glued to an aluminium foil and kraft paper facing. Acceptable products are:
 - .1 Multi-Glass Insulation Ltd. "Multi-Flex MKF";
 - .2 Glass-Cell Fabricators Ltd. "R-FLEX";
 - .3 Owens Corning Pipe and Tank Insulation;
 - .4 Johns Manville Inc. Pipe and Tank Insulation.
- .3 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m³ (1½ lb/ft³) density, 40 mm (1½") thick, with a factory applied vapour barrier facing. Acceptable products are:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .4 Flexible foam elastomeric sheet is to be sheet form, CFC free, closed cell, self-adhering elastomeric nitrile rubber insulation with a water vapour permeability rating of 0.08 in accordance with ASTM E96 Procedure A. Acceptable products are:
 - .1 Armacell "AP/Armaflex SA";
 - .2 IK Insulation Group "K-Flex Duct Wrap", S2S.

2.9 INSULATING COATINGS

- .1 Equal to Robson Thermal Manufacturing Ltd. insulating coatings as follows:
 - .1 anti-condensation coating, "No Sweat-FX";
 - .2 thermal insulating coating, "ThermaLite".

2.10 INSULATION FASTENINGS

- .1 Wire – minimum #15 gauge galvanized annealed wire.
- .2 Aluminium Banding – equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm (½") wide, 0.6 mm (1/16") thick aluminium strapping.
- .3 Duct Insulation Fasteners – weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm (1½") square plastic or zinc plated steel self-locking washers.
- .4 Tape Sealant – equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match surface being sealed.
- .5 Mineral Fibre Insulation Adhesive – clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with type of material to be secured, and WHMIS classified as non-hazardous.
- .6 Flexible Elastomeric Insulation Adhesive – Armacell "Armaflex" #520 air-drying contact adhesive.

- .7 Closed Cell Foamed Glass Insulation Adhesive – Pittsburgh Corning PC88 multi-purpose 2-component adhesive.
- .8 Lagging Adhesive – white, brush consistency, ULC listed and labelled, 25/50 fire/smoke rated lagging adhesive for canvas jacket fabric, suitable for colour tinting, complete with fungicide and washable when dry.
- .9 Screws – No. 10 stainless steel sheet metal screws.

2.11 INSULATION JACKETS AND FINISHES

- .1 Canvas Jacket Material – ULC listed and labelled, 25/50 fire/smoke rated, roll form, minimum 170 g (6 oz.).
- .2 Roll Form Sheet and Fitting Covers – minimum 15 mm (1/2") thick white PVC, 25/50 fire/smoke rated tested in accordance with ULC S102, complete with installation and sealing accessories. Acceptable products are:
 - .1 Proto Corp. "LoSMOKE";
 - .2 The Sure-Fit System "SMOKE-LESS 25/50";
 - .3 Johns Manville Inc. "Zeston" 300.
- .3 Rigid Aluminium Jacket – equal to ITW Insulation Systems Canada "Lock-on" 0.406 mm (0.016") thick embossed aluminum jacket material to ASTM B209, factory cut to size and complete with polysurlyn moisture barrier and continuous modified Pittsburgh Z-Lock, butt straps with "Fabstraps" to weatherproof the end to end joints, and 2-piece epoxy coated pressed aluminum fittings with weather locking edges.
- .4 Flexible foam elastomeric insulation protective coating equal to Armacell "WB Armaflex" weatherproof, water-based latex enamel finish.

3. Execution

3.1 GENERAL INSULATION APPLICATION REQUIREMENTS

- .1 Unless otherwise noted, do not insulate the following:
 - .1 factory insulated equipment and piping;
 - .2 heating piping within radiation unit enclosures, including blank filler sections of enclosures;
 - .3 branch domestic water piping located under counters to serve counter mounted plumbing fixtures and fittings;
 - .4 exposed chrome plated domestic water angle supplies from concealed piping to plumbing fixtures and fittings;
 - .5 heated liquid system pump casings, valves, strainers and similar accessories;
 - .6 heating system expansion tanks;
 - .7 manufactured expansion joints and flexible connections;
 - .8 acoustically lined ductwork and/or equipment;
 - .9 factory insulated flexible branch ductwork;
 - .10 piping unions, except for unions in "cold" category piping.
- .2 Install insulation directly over pipes and not over hangers and supports.
- .3 Do not apply insulation until leakage tests have been satisfactorily completed.
- .4 Ensure that all surfaces to be insulated are clean and dry.

- .5 No material including tapes, adhesives, etc. used as part of an insulation assembly shall be rated greater than 25/50 Article 2.1 entitled "FIRE HAZARD RATING OF INSULATION" shall be used within a "plenum" as defined in OBC.
- .6 Install work generally in accordance with TIAC "NATIONAL INSULATION STANDARDS MANUAL" except conform with manufacturer's published instructions and recommendations and the requirements specified herein this Section of the Specification.
- .7 Ensure that the ambient temperature is minimum 55°F (13°C) for at least one (1) day prior to the application of insulation, and for the duration of insulation work.
- .8 Install piping insulation continuous through pipe openings and sleeves.
- .9 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.
- .10 Provide proper covering shields, sized to suit the insulated pipe, between the pipe hanger or support and the insulation for all piping not supported by roller hangers or supports.
- .11 Where roller hangers and supports are used, steel protection saddles will be supplied and installed as part of the piping work. Pack the saddle voids with fibreglass insulation.
- .12 When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect the insulation jacketing from the action of condensation at its junction with the metal.
- .13 When insulating vertical piping risers 75 mm (3") diameter and larger, use insulation support rings welded directly above lowest pipe fitting, and thereafter at 4.5 m (14.7') centres and at each valve and flange. Insulate as per Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.
- .14 Where mineral fibre rigid sleeve type insulation is terminated at valves, equipment, unions, etc., neatly cover exposed end of insulation with a purpose made PVC cover on "cold" piping, and with canvas jacket material on "hot" piping.
- .15 Carefully and neatly gouge out insulation for proper fit where there is interference between weld bead, mechanical joints, etc., and insulation. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles.
- .16 Where thermometers, gauges, and similar instruments occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in insulation and provide a suitable grommet in the opening.
- .17 The final appearance and finish of exposed mechanical work depends to a large degree on the quality of the insulation application, therefore, first class workmanship will be insisted upon.
- .18 For all piping system components and for equipment or sections of equipment which require insulation but also access to permit maintenance or adjustment, design and install the insulation to permit easy removal and replacement.
- .19 For items such as "circuit balancing valves" which are supplied with insulating accessories, specified in other Sections of the Specification, incorporate the packing into the pipe insulation, but do not contravene fire hazard ratings of CAN/ULC-S102.

3.2 INSULATION FOR HORIZONTAL PIPE AT HANGERS AND SUPPORTS

- .1 At each hanger and support location for piping 50 mm (2") diameter and larger and scheduled to be insulated, except where roller hangers and/or supports are required, and unless otherwise specified, supply a factory fabricated section of phenolic foam pipe insulation with integral vapour barrier jacket and captive galvanized steel shield. Supply insulation sections to piping installers for installation as pipe is erected.

3.3 PIPE INSULATION REQUIREMENTS - MINERAL FIBRE

- .1 Except where other types of insulation are specified for portions of piping in succeeding articles in this Section, insulate the following pipe with rigid fibreglass pipe insulation of the thickness noted:
 - .1 domestic cold water piping, less than 100 mm (4") dia. – 25 mm (1") thick;
 - .2 domestic cold water piping, greater than or equal to 100 mm (4") dia. – 40 mm (1-½") thick;
 - .3 domestic hot water piping, less than 40 mm (1-½") dia. – 25 mm (1") thick;
 - .4 domestic hot water piping, greater than or equal to 40 mm (1½") dia. – 40 mm (1-½") thick;
 - .5 storm drainage piping from roof drains to the point where main vertical risers extend straight down, without offsets, and connect to horizontal underground mains – 25 mm (1") thick;
 - .6 tempered domestic water piping, supply and return, less than 40 mm (1-½") dia. – 25 mm (1") thick;
 - .7 condensate drainage piping from fan coil unit or any other air conditioning system/unit drain pans to main vertical drain risers or to indirect drainage point – 25 mm (1") thick;
 - .8 hot water heating piping, supply and return, less than 40 mm (1-½") dia. – 40 mm (1-½") thick;
 - .9 hot water heating piping, supply and return, greater than or equal to 40 mm (1-½") dia. – 50 mm (2") thick;
- .2 Secure overlap flap of the sectional insulation jacket tightly in place. Cover section to section butt joints with tape sealant.
- .3 Insulate fittings with sectional pipe insulation mitred to fit tightly, and cover butt joints with tape sealant, or, alternatively, wrap fittings with blanket mineral fibre insulation to a thickness and insulating value equal to the sectional insulation, secure in place with adhesive and/or wire, and cover with PVC fitting covers.
- .4 Unless otherwise specified, insulate unions, valves, strainers, and similar piping system accessories in "cold" piping with cut and tightly fitted segments of sectional pipe insulation with joints covered with tape sealant, or, alternatively, wrap piping union, valve, strainer, etc., with blanket mineral fibre and cover with PVC covers as for paragraph above.
- .5 Terminate sectional insulation approximately 50 mm (2") from flange or coupling on each side of flange or coupling. Cover flange or coupling with a minimum 50 mm (2") thickness of blanket mineral fibre insulation wide enough to butt tightly to ends of adjacent sectional insulation. Secure blanket insulation in place and cover with a purpose made PVC coupling cover.
- .6 Take special care at concealed water rough-in piping at plumbing fixtures to ensure piping is properly insulated. If necessary due to space limitations, use 12 mm (½") thick sectional pipe insulation in lieu of 25 mm (1") thick insulation.

3.4 PIPE INSULATION REQUIREMENTS – FLEXIBLE FOAM ELASTOMERIC

- .1 Install flexible elastomeric pipe insulation in strict accordance with manufacturer's published instructions to suit the application, and using adhesive, joint sealants and finish to produce a water-tight installation. Insulate following pipe with flexible elastomeric pipe insulation of thickness indicated:
 - .1 refrigerant suction and hot gas piping– 25 mm (1") thick.

3.5 PIPE INSULATION REQUIREMENTS – FIRE RATED INSULATION

- .1 Where pipe (inside building and above ground) which is to be insulated as specified above penetrates fire rated construction, provide fire-rated, non-combustible sectional insulation on portion of pipe in fire barrier and for a distance of 50 mm (2") on either side of fire barrier. Insulation thickness is to be as specified, but in any case minimum 25 mm (1").

3.6 INSTALLATION OF BARRIER FREE LAVATORY INSULATION KITS

- .1 Provide manufactured insulation kits to cover exposed drainage and water piping under barrier free lavatories.

3.7 EQUIPMENT INSULATION REQUIREMENTS – SEMI-RIGID MINERAL FIBRE

- .1 Insulate following equipment with semi-rigid mineral fibre board insulation of thickness indicated:
 - .1 heating main air separator – 40 mm (1-½") thick;
- .2 Install insulation as required to fit shape and contour of equipment. Secure insulation in place with adhesive, and with aluminum straps on 450 mm (18") centres. Apply a 6 mm (¼") thick skim coat of insulating cement, then, when insulating cement has dried, apply a 6 mm (¼") thick coat of cement trowelled smooth.
- .3 For "cold" equipment, prime insulation with suitable sealer and apply a jacket of glass thread reinforced foil and kraft paper vapour barrier jacket material laminated in place with a full coverage of adhesive.
- .4 Provide removable and replaceable insulated metal covers for equipment with removable heads to permit heads to be removed and replaced without damaging adjacent insulation work.

3.8 EQUIPMENT INSULATION REQUIREMENTS – REMOVABLE/REUSABLE TYPE

- .1 Provide custom designed and manufactured removable and reusable insulation covers for following:
 - .1 plate type heat exchanger(s);
- .2 Provide "wrap type" removable and reusable insulation covers for "cold" circuit balancing valves, backflow preventers, and similar items, and for steam traps and similar items requiring service in piping less than 150 mm (6") dia.

3.9 DUCTWORK INSULATION REQUIREMENTS – MINERAL FIBRE

- .1 Insulate following ductwork systems inside building and above ground with mineral fibre insulation of thickness indicated:
 - .1 outside air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections, or, if mixing plenums or sections are not provided, to first heating coil, or if both mixing plenums or sections and heating coil sections are not provided, and fresh air is not tempered, then the fresh air ductwork system complete – minimum 40 mm (1-½") thick as required;

- .2 mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
 - .3 supply air ductwork outward from fans, except for supply ductwork exposed in area it serves – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
 - .4 exhaust discharge ductwork for a distance of 3 m (10') downstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 3 m (10') distance – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
 - .5 any other ductwork, casings, plenums or sections specified or detailed on drawings to be insulated – thickness as specified.
- .2 Provide rigid board type insulation for casings, plenums, and exposed rectangular ductwork. Provide blanket type insulation for round ductwork and concealed rectangular ductwork.
 - .3 Liberally apply adhesive to surfaces of exposed rectangular ducts and/or casings. Accurately and neatly press insulation into adhesive with tightly fitted butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom and side surfaces. Secure and seal joints with 75 mm (3") wide tape sealant. Additional installation requirements as follows:
 - .1 at trapeze hanger locations, install insulation between duct and hanger;
 - .2 provide drywall type metal corner beads on edges of ductwork, casings and plenums in equipment rooms, service corridors, and any other area where insulation is subject to accidental damage, and secure in place with tape sealant.
 - .4 Liberally apply adhesive to surfaces of concealed rectangular or oval ductwork, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom surfaces. Secure and seal joints with 75 mm (3") tape sealant. At each trapeze type duct hanger, provide a 100 mm (4") wide full length piece of rigid mineral fibre board insulation between duct and hanger.
 - .5 Accurately cut sections of insulation to fit tightly and completely around exposed and concealed round or oval ductwork. Liberally apply adhesive to surfaces of duct, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Seal joints with tape sealant. At duct hanger locations install insulation between duct and hanger. At each hanger location for concealed ductwork where flexible blanket insulation is used, provide a 100 mm (4") wide full circumference strip of semi-rigid board type duct insulation between duct and hanger.
 - .6 Insulation application requirements common to all types of rigid ductwork are as follows:
 - .1 at duct connection flanges, insulate flanges with neatly cut strips of rigid insulation material secured with adhesive to side surfaces of flange with a top strip to cover exposed edges of the side strips, then butt the flat surface duct insulation up tight to flange insulation, or, alternatively, increase insulation thickness to depth of flange and cover top of flanges with tape sealant;
 - .2 installation of fastener pins and washers is to be concurrent with duct insulation application;
 - .3 cut insulation fastener pins almost flush to washer and cover with neatly cut pieces of tape sealant;
 - .4 accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers;
 - .5 prior to concealment of insulation by either construction finishes or canvas jacket material, patch vapour barrier damage by means of tape sealant.

3.10 DUCTWORK INSULATION REQUIREMENTS – FLEXIBLE ELASTOMERIC

- .1 Insulate exposed exterior ductwork (except fresh air intake ductwork) and associated plenums and/or casings outside building with minimum 40 mm (1-½") thick flexible elastomeric sheet insulation as required, applied in 2 minimum 20 mm (¾") thick layers with staggered tightly butted joints.
- .2 Install with adhesive in strict accordance with manufacturer's instructions to produce a weather-proof installation. Ensure sheet metal work joints are sealed watertight prior to applying insulation.

3.11 APPLICATION OF INSULATING COATINGS

- .1 Apply, in accordance with manufacturer's instruction, insulating coatings to following bare metal surfaces:
 - .1 paint bare metal surfaces clear of "cold" piping and/or equipment insulation for a distance of from 300 mm (12") to 600 mm (24") clear of pipe or equipment insulation, with "No Sweat-FX" anti-condensation coating;
 - .2 paint bare metal surfaces associated with mechanical systems with an operating temperature 60°C (140°F) with "ThermaLite" insulating coating.
- .2 Apply coatings with a brush. Remove any splatter or excess coating from adjacent surfaces.

3.12 INSULATION FINISH REQUIREMENTS

- .1 Unless otherwise shown and/or specified, jacket exposed mineral fibre insulation, and calcium silicate duct insulation work inside building with canvas secured in place with a full covering coat of lagging adhesive. Accurately cut canvas with scissors or a knife. Do not rip or tear canvas to size. Remove lagging adhesive splatter from adjacent uninsulated surfaces.
- .2 Jacket exposed pipe insulation work inside building with white sheet PVC and fitting covers. Install sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal joints to produce a neat water-tight installation. Provide slip-type expansion joints where required by manufacturer's instructions.
- .3 Apply 2 heavy coats of "PITTCOTE 404" coating with 24 hr. between coats to foamed glass insulation exposed above grade.
- .4 Install rigid aluminum jacket material tightly in place with overlapped circumferential joints positioned to shed water and covered with butt straps supplied with the jacket. Provide aluminum jacket for following insulation:
 - .1 Outdoor Refrigerant Piping.

END OF SECTION

1. General

1.1 SUBMITTALS

- .1 Submit shop drawings with product data sheets for variable frequency drives (VFDs). Include:
 - .1 construction and performance details;
 - .2 wiring and control schematics;
 - .3 dimensions of units;
 - .4 calculations specific to installation showing total harmonic voltage distortion is less than 5%;
 - .5 certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.
- .2 Submit a start-up and installation certification letter from supplier of VFDs as specified in Part 3 of this Section;
- .3 Prepare list of parameters for uploading for Owner's future use as specified in Part 3 of this Section. Load on USB type flash drive and submit to Consultant.
- .4 Where extended warranty is specified to be included, include a copy of VFD extended warranty in each Operating and Maintenance Manual. Prior to Substantial Performance of Work, submit a copy of warranty to Owner.
- .5 Additionally, coordinate with Prime Contractor and Electrical Contractor to ensure shop drawings clearly identify proposed VFDs and connected motors are 100% compatible and Mechanical Contractor to sign off on selected VFDs.

1.2 COORDINATION WITH ELECTRICAL DIVISIONS

- .1 This Section specifies VFD requirements for motors. VFDs packaged with various system equipment are to comply with specifications of this Section.
- .2 Each VFD to be approved by respective manufacturer of VFD and connected motors, as suitable for installation on scheduled motors. VFD output current rating to match or exceed connected motor nameplate full load current rating.
- .3 Coordinate and review with Electrical Divisions, responsibility requirements for supply of VFDs, harmonic filters and requirements for control and power conductors and connections.
- .4 Check motors are equipped with AEGIS or approved equal, shaft grounding ring system to protect bearings from damage in motors by diverting harmful shaft voltages and bearing currents to ground.
- .5 Additionally, review and confirm responsibilities with Consultant and Prime Contractor.

2. Products

2.1 VFD BASIC REQUIREMENTS

- .1 VFDs supplied on project to be products of same manufacturer and be CSA approved, ULC listed and labelled. Base specified product is Danfoss VLT HVAC series units that include compliance with following standards:
 - .1 CSA C22.2 No.14 Industrial Control Equipment;
 - .2 UL 508 - Industrial Control Equipment;
 - .3 UL 508C – Power Conversion Equipment;
 - .4 NEMA ICS 7 - Adjustable-Speed Drives.

- .2 Basis for limiting harmonics is to be provided generally to IEEE Standard 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems, except intended for user's electrical distribution system with point of common coupling (where harmonic limits are assessed) to be set at input terminals of harmonic mitigating equipment.
- .3 VFDs to include following basic requirements:
 - .1 regardless of HP rating are to be of same VFD model; I/O and control circuit boards as well as keypads are to be identical and interchangeable regardless of HP rating;
 - .2 to be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without safety tripping or component damage (flying start);
 - .3 6-pulse width modulated (PWM) AC to AC converter utilizing latest isolated gate bipolar transistor (IGBT) technology; PWM switching pattern to include a motor flux optimization circuit that automatically reduces applied motor voltage to the motor to optimize energy consumption and audible motor noise;
 - .4 carrier frequency control circuit that reduces carrier frequency based on actual VFD temperature allowing higher carrier frequency without derating VFD or operating at high carrier frequency only at low speeds;
 - .5 provisions that determines motor torque and flux every 25 microseconds (40,000 times per second);
 - .6 completely assembled and tested by manufacturer in their facility;
 - .7 designed to provide at least 250,000 hours mean time before failure (MTBF) when specified preventative maintenance is performed.
 - .8 bypass system completely factory wired and tested;
 - .9 door interlocked padlockable disconnect switch to disconnect all input power from drive and all internally mounted options;
 - .10 control panel keyboard and display with password protection against parameter changes.

2.2 VFD RATINGS

- .1 VFDs to be rated to operate from 3 phase input voltage of 208 or 600 volts $\pm$ 10%, as scheduled, and frequency range from 48 to 63 Hz. In addition, a tolerated voltage window to allow system to operate from a line of +30% to -35% nominal voltage. System to incorporate circuitry that allows drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
- .2 VFDs to employ a full wave rectifier to prevent input line notching and operate at a minimum fundamental input power factor of 0.97 at all speeds and loads.
- .3 VFDs efficiency to be 97% or better at full speed and load.
- .4 Output voltage and current ratings to match adjustable frequency operating requirements of standard 3 phase, 60 Hz, NEMA design B inverter-duty motors in compliance with NEMA-MG1, Part 31 Standard. Overload current capacity for variable torque overload capacity to be 110% of rated current for 1 minute out of 10 minutes and 130% for 2 seconds. Output frequency to be adjustable between 0 and 500 Hz.
- .5 Open loop static speed regulation to be 0.1% to 0.3% (10% of motor slip). Dynamic speed accuracy to be 4%-sec. or better open loop.
- .6 When a suitable motor is used, drive provides breakaway torque equal to 200% of rated motor torque. Torque response time to be 5 ms or less.
- .7 Enclosures:
 - .1 in climate controlled areas – minimum NEMA 12 with drip shield;
 - .2 in non-climate controlled areas – NEMA 3R.

2.3 HARMONIC FILTERS AND REACTORS

- .1 VFDs to include internal 5% impedance AC line reactor (or equivalent 5% impedance dual positive and negative DC bus reactors) provided as a standard to reduce input current harmonic content and provide isolation from power line transients and to reduce RFI emissions.
- .2 VFDs serving motors sized 18 kw (25 HP) or more to be provided with harmonic filters to limit harmonics distortion produced by each drive to following maximum levels as measured on input side of drive:
 - .1 Total harmonic distortion (voltage) – 5%;
 - .2 Total harmonic distortion (current) – 10%.
- .3 Harmonic filter to be equivalent to MIRUS International Inc. “LINEATOR AUHF” series, with features as follows:
 - .1 manufactured and tested in accordance with latest applicable standards of ULC, CSA and NEMA;
 - .2 treat characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5th, 7th, 11th, 13th, etc.);
 - .3 passive inductor/capacitor network;
 - .4 low capacitive reactance (KVAR) of less than 20% of kVA rating, to ensure compatibility with engine generator sets;
 - .5 full load efficiency of harmonic mitigation equipment / VFD combination to be greater than 96%;
 - .6 copper wiring;
 - .7 220°C system insulation class and temperature rise of 130°C;
 - .8 anti-vibration pads between reactor or transformer core and enclosure;
 - .9 manufacturer’s standard ventilated, NEMA-3R enclosure.
- .4 Acceptable harmonic mitigation product manufacturers are:
 - .1 MIRUS International Inc.;
 - .2 Synergy Energy Ltd. (Harmonizer);
 - .3 MTE Corporation.

2.4 CONTROLS AND ADJUSTMENT FUNCTIONS

- .1 Include for following:
 - .1 programmable critical frequency lockout ranges to prevent VFD from operating load continuously at an unstable speed;
 - .2 proportional integral derivative (PID) speed loop regulators with an auto tune function as well as manual adjustments; PID set point controllers to allow pressure or flow signals to be connected to VFD, using microprocessor in VFD for closed loop control; includes 250 mA of 24 VDC auxiliary power and capability of loop powering a transmitter supplied by others; two parameter sets for first PID allowing sets to be switched via a digital input, serial communications or from keypad for night setback, summer/winter set points, etc; independent, second PID loop to utilize second analogue input and modulate analogue outputs to maintain set point of an independent process (ie. valves, dampers, etc.); set points, process variables, etc. to be accessible from serial communication network;
 - .3 programmable analogue inputs that accept current or voltage signals;
 - .4 programmable analogue outputs (0-20 mA or 4-20 mA), that may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data;
 - .5 programmable digital inputs;
 - .6 programmable digital Form-C relay contact outputs for programmable on and off delay times and adjustable hysteresis; rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS;

- .7 run permissive circuit - for damper or valve control; dry contact closure to signal damper to open (VFD motor does not operate); when damper is fully open, a normally open dry contact (end-switch) closes; closed end-switch is wired to a VFD digital input and allows motor operation; two separate safety interlock inputs, when either is opened, motor to coast to stop, and damper to close;
 - .8 two independently adjustable accel and decel ramps with 1 to 1800 seconds adjustable time ramps;
 - .9 fireman's override input - upon receipt of a contact closure from fireman's control station, VFD operates in one of two modes: operate at a programmed predetermined fixed speed or operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback; mode overrides all other inputs (analogue/digital, serial communication and keypad commands), except customer defined safety run interlock, and forces motor to run in one of the two modes; "Override Mode" to be displayed on control panel; upon removal of override signal, VFD resumes normal operation.
- .2 Operator Control Panel:
- .1 front mounted plug-in operator control panel consisting of keypad, multi-line backlit LCD display for programming and fault diagnostics;
 - .2 keys (switches) for H-O-A, and manual speed control INCREASE/DECREASE;
 - .3 menu navigation and parameter selection keys for custom programming;
 - .4 HELP key for assistance with programming and troubleshooting;
 - .5 date and time clock - clock to have a battery backup with 10 years minimum life span; clock to be used to date and time stamp faults and record operating parameters at time of fault; if battery fails VFD automatically reverts to hours of operation since initial power up; clock also to be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays; VFD to have digital input that allows an override to time clock (when in off mode) for a programmable time frame; four (4) separate, independent timer functions that have both weekday and weekend settings;
 - .6 parameter names, fault messages, warnings and other information to be displayed in complete words or standard abbreviations to allow user to understand what is being displayed without use of a manual or cross reference table, as follows:
 - .1 "HAND" position to start drive and modify reference frequency by use of INCREASE/DECREASE keys;
 - .2 "OFF" position stops drive;
 - .3 "AUTO" position allows drive to be started or stopped using whichever remote start/stop command configured; drive speed controlled by external speed reference input or by PID controller.
 - .4 applicable operating values to be capable of being displayed in engineering (user) units; operating displayed include:
 - .1 Output Frequency;
 - .2 Motor Speed (RPM, %, or Engineering units);
 - .3 Motor Current;
 - .4 Drive Temperature;
 - .5 DC Bus Voltage;
 - .6 Output Voltage.

2.5 PROTECTIVE FUNCTIONS

- .1 For each programmed warning and fault protection function, keypad displays a message in complete words or standard abbreviations. Three most recent fault messages and times are stored in drive's fault history.
- .2 VFDs include metal oxide varistors (MOV's) for phase to phase and phase to ground line voltage transient protection.

- .3 Short circuit current rating of 100,000 amps to be provided per UL 508C without relying on line fuses.
- .4 Ground fault protection, motor phase loss protection and phase unbalance protection to be provided. Single phase protection to be provided on input and output.
- .5 VFDs to provide electronic motor overload protection qualified per UL 508C.
- .6 Protection to be provided for AC line or DC bus overvoltage at 130% of maximum rated or undervoltage at 65% of minimum rated.
- .7 Stall protection to be programmable to provide a warning or stop VFD after motor has operated above a programmable torque level for a programmed time limit.
- .8 Underload protection to be programmable to provide a warning or stop VFD after motor has operated below a selected underload curve for a programmed time limit.
- .9 Overtemperature protection to provide a warning if power module temperature is less than 5C° (9F°) below overtemperature trip level.
- .10 Input terminal to be provided for connecting a motor thermistor (PTC type) to drive's protective monitoring circuitry. An input to also be programmable to monitor an external relay or switch contact.
- .11 VFDs through 56 kW (75HP) to be protected from damage from input and output power miss-wiring. VFD to sense this condition and display an alarm on control panel.
- .12 EMI / RFI filters to be provided as per standard EN 61800-3.
- .13 dv/dt long lead filter (LRC) to protect power system network.
- .14 Automatic reset feature to automatically reset selected faults and attempt to restart drive based on control parameters such as adjustable time delays, number of restart attempts and duration of restart attempts. Faults include following:
 - .1 Overcurrent;
 - .2 Overvoltage;
 - .3 Undervoltage;
 - .4 Analogue input signal reference loss;
 - .5 External fault.
- .15 Additional built-in protection circuits include:
 - .1 Overcurrent trip limit;
 - .2 Undervoltage trip limit;
 - .3 Microprocessor fault;
 - .4 Keypad control panel loss;
 - .5 Serial communication loss;
 - .6 External fault interlock inputs;
 - .7 Adjustable output frequency and motor speed limits;
 - .8 Pass code parameter change protection;
 - .9 Keypad operator control lockout.

2.6 MANUAL BYPASS

- .1 VFDs associated with pumping systems such as heating water circulating pumps shall be provided with a Three-Contactor By-Pass. The Three-Contactor By-Pass shall be wired such that the Central Building Control System will not interfere with the By-Pass operation.

2.7 COMMUNICATIONS

- .1 VFD to be complete with communications connections of integrated RS-485 port suitable to allow for VFD to be controlled, supervised, monitored and programmed from one remote control panel or PC with VFD system Windows based application software.
- .2 Communications protocol to be industry standard compatible to BAS of building. Coordinate exact requirements with Mechanical Divisions controls contractor and BAS vendor to ensure appropriate interface module is supplied for drive system to communicate with BAS being used in building with interface capability to include serial communication standard protocols to match existing building automation system.
- .3 Serial communication to be used for drive setup, diagnostic analysis, monitoring and control with capabilities to include, but not be limited to:
 - .1 run-stop control;
 - .2 speed set adjustment;
 - .3 proportional/integral/derivative PID control adjustments;
 - .4 current limit;
 - .5 accel/decel time adjustments;
 - .6 ability to lock and unlock control panel keypad;
 - .7 capability of allowing BAS to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature;
 - .8 monitoring relays output status, and digital input status and analogue output values;
 - .9 transmitting diagnostic warning and fault information over communications bus to BAS or other monitoring system;
 - .10 remote fault reset.

2.8 WARRANTY

- .1 VFDs to be warranted free from defective labour and materials for period of 36 months from date of Substantial Performance of the Work. Include for initial one year Contract warranty and an additional 2 year extended warranty direct to Owner. Extended warranty terms and conditions are to be identical to one year Contract warranty, and extended warranty period is to commence day Contract warranty expires.

2.9 SITE SERVICES, TRAINING AND MAINTENANCE MANUALS

- .1 Provide onsite inspection, testing, start up and verification work of VFDs and filters by manufacturer's authorized technician. Allow a minimum of 1/2 day per system. Also include for a second visit to site of one (1) day duration to train operating personnel in operation and maintenance of drives. Provide verification reports and supply soft copy of system programming parameters.
- .2 Upon completion of installation, supplier of VFDs to supply minimum one hard copy of complete sets of service and maintenance manuals including wiring and connection diagrams. Include for digital copy loaded onto a USB type flash drive.
- .3 Provide system training and instructions on operating and maintenance procedures. Refer to additional requirements in General Instructions section and Division 01.
- .4 Include for manufacturer's authorized technician to be in attendance to assist Commissioning Agent during commissioning process.

2.10 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers are Danfoss-Graham (VLT HVAC Drive FC102 Series), ABB, Siemens Electric. All variable frequency drives shall be supplied by one (1) manufacturer.

3. Execution

3.1 INSTALLATION OF VARIABLE FREQUENCY DRIVES

- .1 Provide variable frequency drives for motorized equipment in accordance with drawing requirements. Coordinate requirements for conductors and connections with Electrical Divisions Contractor.
- .2 VFDs supplied to be products of same manufacturer.
- .3 Include manual bypass with each VFD as noted or specified.
- .4 Wire length between VFD and motor to be less than 15 m (50') with properly sized conductors.
- .5 Install VFDs in accordance with manufacturer's instructions. VFDs installation to include upstream protection, either fuses or circuit breakers in accordance with VFD manufacturer's recommendations and local electrical code requirements. Advise Electrical Divisions Contractor of these requirements in addition to required conductors and connections. Provide required control wiring and connections.
- .6 Review VFD and related connected motor installation. Provide local disconnect to VFD in accordance with local governing code requirements.
- .7 Mount VFDs operating controls/display at approximately 1.5 m (5') above finished floor level, unless otherwise directed by Consultant. Provide dual back to back C-channel support system from floor to ceiling, complete with cross bracing to form a solid backing for VFD mounting at required locations.
- .8 Properly support VFDs. Coordinate exact locations on site with Consultant.
- .9 Where VFDs are required for custom made air handling units VFDs to be supplied, factory mounted on fan cabinets, and "load" side connected to fan motors by air handling unit manufacturer. "Line" side power wiring to these VFDs to be provided as part of Electrical Divisions work.
- .10 Where VFDs are required for pumps, mount each VFD generally where shown but with exact location to ensure VFD is accessible in accordance with local governing electrical code requirements. "Line" and "load" side power wiring to these VFDs to be provided as part of Electrical Divisions work.
- .11 Install harmonic mitigation filter equipment as follows:
 - .1 in accordance with manufacturer's recommended installation practices and to comply with applicable local governing codes;
 - .2 provide each VFD as specified in per Part 2, with a harmonic filter sized in accordance with manufacturer's rating table to match rating of connected VFD;
 - .3 mount harmonic filters sized up to 110 kW (150 HP) typically to wall/ceiling construction using suitable brackets, metal C-channel framework and vibration isolators assemblies, ensuring full support of units acceptable to local governing authorities;
 - .4 ensure adequate ventilation and space for access is provided;
 - .5 review exact locations with Consultant prior to installation;
 - .6 coordinate with Electrical Division Contractor to ensure units are connected complete to line side supply feed and to VFD in accordance with VFD manufacturer's instructions for standalone VFDs and VFD system with bypass; include required control wiring and connections.
- .12 Ground and bond equipment as per local governing electrical code requirements and manufacturer's instructions.

- .13 Provide engraved lamaroid nameplate identifying each piece of equipment. Review exact nomenclature with Consultant.

3.2 TESTING, START-UP AND VERIFICATION

- .1 When installation of VFDs and filters are complete, arrange for respective equipment manufacturer/supplier to:
 - .1 supply factory authorized technician at site for minimum of 4 hours per system to examine installation and connection of equipment, and to perform start-up and set-up procedures in conjunction with equipment start-up and testing procedures;
 - .2 supply factory authorized technician at site for minimum of one 8 hour day to train Owner's personnel on equipment operating and maintenance procedures;
 - .3 prepare and submit letter certifying equipment have been properly installed, tested and adjusted, and are in proper operating condition;
 - .4 submit list of start-up and testing parameters for uploading for future use by Owner and start-up data entries to include motor nameplate power, speed, voltage, frequency and current.
- .2 Perform following:
 - .1 Inspect equipment and accessories for verification of proper operation and installation.
 - .2 Inspect interface wiring to BAS for verification of proper operation and installation.
 - .3 Verify wire terminations to VFDs and bypass and to operational circuitry.
 - .4 Verify installation of VFD, bypass and motor being driven for proper operation and reliability.
 - .5 Verify connections and communications to BAS or other monitoring/remote control system are of proper operation and installation and of full communications compatibility.
 - .6 Measurement for verification of proper operation on each of following items:
 - .1 Motor voltage and frequency;
 - .2 Verification of proper motor operation;
 - .3 Control input for proper building automation system interface and control calibration.
 - .7 Calibration check for following set points (and adjustment as necessary):
 - .1 minimum speed;
 - .2 maximum speed;
 - .3 acceleration and deceleration rates.
- .3 Verify harmonic compliance with onsite field measurements of both voltage and current harmonic distortion at point of common coupling-input terminals of harmonic mitigating equipment with and without equipment operating. Utilize recording type Fluke 41 or equivalent harmonics analyser displaying individual and total harmonic currents and voltages.
- .4 Document testing and results in a report signed by a Professional Engineer licensed in the Place of Work and authorized by equipment manufacturer. Include for minimum 3 hard copies and electronic copy of report to be submitted to Consultant for review.
- .5 Additionally, refer to applicable installation, testing, coordination and verification requirements in Electrical Divisions Sections.
- .6 Coordinate procedures specified above to be performed by equipment manufacturer/supplier authorized technician with system commissioning work.

END OF SECTION

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies requirements, criteria, methods and execution for mechanical demolition work that are common to one or more mechanical work Sections, and it is intended as a supplement to each Section and is to be read accordingly.

2 PRODUCTS

Not Used

3 EXECUTION

3.01 DISCONNECTION AND REMOVAL OF EXISTING MECHANICAL WORK

- .1 Where indicated on drawings, disconnect and remove existing mechanical work, including hangers, supports, insulation, etc. Disconnect at point of supply, remove obsolete connecting services and make system safe. Cut back obsolete piping behind finishes and cap water-tight unless otherwise specified.
- .2 Scope and extent of demolition or revision work is only generally indicated on drawings. Estimate scope, extent and cost of work at site during bidding period site visit(s). Claims for extra costs for demolition work not shown or specified but clearly visible or ascertainable at site during bidding period site visits will not be allowed.
- .3 If any re-design is required due to discrepancies between mechanical drawings and site conditions, notify Consultant who will issue a Site Instruction. If, in the opinion of Consultant, discrepancies between mechanical drawings and actual site conditions are of a minor nature, required modifications are to be done at no additional cost.
- .4 Where existing mechanical services extend through, or are in an area to serve items which are to remain, maintain services in operation. Include for rerouting existing services concealed behind existing finishes and which become exposed during renovation work, so as to be concealed behind new or existing finishes.
- .5 Unless otherwise specified, remove from site and dispose of existing materials which have been removed and are not to be relocated or reused.

3.02 INTERRUPTION TO AND SHUT-DOWN OF MECHANICAL SERVICES AND SYSTEMS

- .1 Co-ordinate shut-down and interruption to existing mechanical systems with school. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning.
- .2 Upon award of contract, submit a list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform Owner in writing 5 business days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent.

- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.
- .5 Pipe freezing may be used to connect new piping to existing piping without draining existing piping. Pipe freeze equipment is to be equal to "NORDIC FREEZE" equipment supplied by Mag Tool Inc. or Rigid Tool Co. RIGID "SuperFreeze".

END OF SECTION

1 GENERAL

1.01 GENERAL REQUIREMENTS

- .1 Conform to the requirements of Section 20 05 05.
- .2 Provide labour and tools / equipment to conduct the commissioning process as outlined in this specification section.
- .3 Where "Contractor" is referenced herein this section, it shall be understood to mean "Mechanical Division Contractor".

1.02 COMMISSIONING AGENT INVOLVEMENT VERSUS WARRANTY OBLIGATIONS

- .1 Involvement of Commissioning Agent performing duties as described in this Section is not in any way to void or alter any Contractual warranty obligations.

1.03 SUBMITTALS

- .1 Submit to Commissioning Agent, at same time as submittal to Consultant, one copy of each shop drawing or product data sheet associated with equipment or systems to be commissioned.
- .2 Submit for review, a Commissioning Plan with schedule, commissioning procedures for commissioning events, and a copy of Commissioning Agent's commissioning data sheets for equipment/systems to be commissioned.
- .3 Submit a list of commissioning instruments and for each instrument, indicate purpose of instrument and include a recent calibration certificate.
- .4 Submit equipment and system manufacturer's start-up and test report sheets for review a minimum of 1 month prior to equipment and system start-up procedures.
- .5 After start-up and successful pre-functional performance testing and submittal of completed forms, submit, for each system or subsystem, a letter confirming pre-functional performance testing has been successfully completed and system or subsystem is ready for functional performance testing and commissioning process to commence.

1.04 DEFINITIONS

- .1 Commissioning: process of demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, all as further described below.
- .2 Commissioning Agent: commissioning authority who will supervise commissioning process, and who will recommend final acceptance of commissioned mechanical work.
- .3 Start-Up and Adjusting: process of equipment manufacturer's/supplier's technical personnel, with Contractor, starting and operating equipment and systems, making any required adjustments, documenting process, and submitting manufacturer's/supplier's start-up reports to confirm equipment has been properly installed and is operational as intended.

- .4 Pre-Functional Performance Testing: testing, adjusting and operating of components, equipment, systems and/or subsystems, by Contractor, after start-up but before functional performance testing, to confirm components, equipment, systems and/or subsystems operate in accordance with requirements of Contract Documents, including modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets.
- .5 Functional Performance Testing: a repeat of successful pre-functional performance testing by Contractor, in presence of Commissioning Agent and Consultant with completed Commissioning Agent's commissioning documentation sheets to document, validate and verify equipment, systems and subsystems are complete in all respects, function correctly, and are ready for acceptance.
- .6 Commissioning Documentation Sheets: prepared sheets for pre-functional performance testing and for functional performance testing supplied by Commissioning Agent for each piece of equipment/system to be commissioned, each sheet or set of sheets complete with Project name and number, date of commissioning, equipment/system involved, equipment/system name and model number, equipment tag in accordance with drawings, and, for each commissioning procedure listed, a column giving expected data in accordance with Contract Documents, a column to fill in observed data during commissioning, and space for signatures of Contractor and Commissioning Agent.
- .7 Systems Operating Manual: a manual prepared by Commissioning Agent to present an overview of building mechanical systems and equipment to be used by building maintenance personnel to assist them in daily operation of systems.
- .8 Validate: to confirm by examination and witnessing tests correctness of equipment and system operation.

1.05 QUALITY ASSURANCE

- .1 Commissioning work is to be in accordance with requirements of following:
 - .1 CSA Z320, Building Commissioning Standard and Check Sheets;
 - .2 ASHRAE Guideline 0, The Commissioning Process;
 - .3 ASHRAE Guideline 1.1, The HVAC Commissioning Process;
 - .4 Owner designated Commissioning Agent.

1.06 COMMISSIONING OBJECTIVES

- .1 Objectives of commissioning process:
 - .1 to support quality management by means of monitoring and checking installation;
 - .2 to verify equipment/system performance by means of commissioning of completed installation;
 - .3 to move completed equipment/systems from "static completion" state to "dynamic" operating state so as to transfer a complete and properly operating installation from Contractor to Owner.

1.07 TESTING EQUIPMENT

- .1 Supply instruments and test equipment required to conduct start-up, testing and commissioning procedures.

2 PRODUCTS

Not Used

3 EXECUTION

3.01 COMMISSIONING

- .1 Commission work in accordance with requirements of this Section and as required by Commissioning Agent, if applicable.
- .2 Prerequisites to successful completion of commissioning:
 - .1 submittal of signed start-up and test reports;
 - .2 completion of system testing, adjusting and balancing (TAB), and acceptance of TAB reports;
 - .3 permanent electrical and control connections of equipment;
 - .4 successful completion and documentation of pre-functional performance testing;
 - .5 submittal of letters to Consultant certifying systems and subsystems have been started, tested, adjusted, successfully pre-functional performance tested, are ready for functional performance testing, and are in accordance with requirements of Contract Documents.

3.02 PHASING OF COMMISSIONING

- .1 Project will be constructed in phases as described in Architectural documents. Phase commissioning to suit progress and phases of Work.

3.03 DEFICIENCIES LISTED DURING COMMISSIONING

- .1 Correct deficiencies listed by Consultant and Commissioning Agent during commissioning process within 15 calendar days of notification unless agreed otherwise with Consultant, and when deficiencies have been corrected, notify Consultant and Commissioning Agent immediately.

3.04 SYSTEMS TO BE COMMISSIONED

- .1 Mechanical systems to be commissioned include, but are not to be limited to, systems described below. Specific commissioning procedures are to be as directed by Commissioning Agent.
- .2 Commissioning of drainage systems includes:
 - .1 commissioning of drainage pumps and controls by means of tests recommended by manufacturer to confirm proper operation and performance;

- .2 commissioning of equipment such as interceptors and backflow preventers.
- .3 Commissioning of water systems (all piping extended from Municipal main) includes:
 - .1 commissioning of pumps and controls;
 - .2 commissioning of water heaters;
 - .3 commissioning of piping specialties such as backflow preventers, mixing valves, and similar components;
 - .4 commissioning of trap seal primer units, including adjustment of water flows and confirmation of water flow at each connected trap;
 - .5 commissioning of plumbing fixtures.
- .4 Commissioning of cooling systems includes piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during cooling season, a follow-up site visit during cooling season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .5 Commissioning of heating systems includes piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .6 Commissioning of HVAC chemical treatment systems includes feed and monitoring equipment, and testing of system fluids to confirm proper concentration of chemical.
- .7 Commissioning of natural gas system includes pressure regulating equipment. Perform commissioning in accordance with requirements of CAN/CSA B149.1, and any supplemental requirements of governing authorities.
- .8 Commissioning of air handling systems includes equipment, ductwork, ductwork specialties, controls, interlocks, and checking and validating air capacities and flows in accordance with TAB reports.
- .9 Control work commissioning includes confirmation of proper operation of individual control components, and overall operation of controls in conjunction with operation of connected building systems, including heating season/cooling season testing requirements specified above.
- .10 Commissioning of BAS includes confirmation of proper operation of components, input/output points, hardware and software, and demonstration of system performing required procedures.
- .11 Commissioning of noise and vibration control equipment includes noise and vibration measurements to confirm proper operation of equipment.

3.05 COMMISSIONING PROCESS

- .1 Perform commissioning process in stages and include, but not be limited to, following:
 - .1 Stage 1: Commissioning of equipment/systems as listed in this Section, which is a prerequisite to an application for Substantial Performance of the Work and includes supervising and validating results of functional performance testing, and submittal of reviewed Systems Operating Manual.
 - .2 Stage 2: Commissioning work performed 12 months after issue of a Certificate of Substantial Performance and which includes supervision of Contractor's "fine tuning" of equipment/systems through seasonal occupancy, and any other such work to achieve optimal comfort and performance conditions.
 - .3 Stage 3: Successful completion of satisfactory equipment/system operation during 1st month after issue of a Certificate of Total Performance of the Work.
 - .4 Stage 4: Successful completion of satisfactory equipment/system operation during 3rd month after issue of a Certificate of Total Performance of the Work.
 - .5 Stage 5: Successful seasonal commissioning of building.

3.06 RESPONSIBILITIES OF CONTRACTOR

- .1 During construction phase, Contractor is to:
 - .1 prepare and submit an installation schedule which includes a time schedule for each activity with lead and lag time allowed and indicated, shop drawing and working detail drawing submissions, and major equipment factory testing and delivery dates;
 - .2 prepare and submit a commissioning schedule which is to include a time schedule coordinated with installation schedule referred to above and Consultant, and allowances for additional time for re-tests as may be required, and update schedule on a monthly basis as required;
 - .3 promptly correct reported deficient work, and report when corrective work is complete;
 - .4 where required by Codes and/or Specification, retain equipment manufacturers/suppliers or independent 3rd parties to certify correct installation of equipment/systems;
 - .5 under supervision of equipment manufacturers/suppliers, start-up and adjust equipment to design requirements, and submit start-up sheets which include equipment data such as manufacturer and model number, serial number where applicable, and performance parameters, all signed by equipment manufacturer/supplier and Contractor;
 - .6 complete Manufacturer's commissioning data sheets for multiple items of smaller equipment such as air terminal boxes, fan coil units, backflow preventers, etc., submit sheets to Consultant, accompany Consultant for an on-site check of 30% of data sheet information for each type of equipment, and perform any corrective action required as a result of site checks;

- .7 perform system testing, adjusting and balancing and, when complete, issue a copy of final report to Consultant for review and a site check of results, and perform any corrective work required as a result of site checks by Consultant;
 - .8 in accordance with updated commissioning schedule and actual progress at site, certify in writing to Consultant that equipment and/or systems are complete, have been checked, started and adjusted, successfully pre-functional performance tested and documented, and are ready for functional performance testing and commissioning procedures, giving Consultant a minimum of 5 working days' notice;
 - .9 perform system and subsystem functional performance testing, and submit to Consultant, completed and signed functional performance testing and commissioning data sheets.
- .2 During post construction phase, Contractor is to:
- .1 optimize system operation in accordance with building occupant's needs and comments;
 - .2 complete commissioning procedures, activities, and performance verification procedures that were delayed or not concluded during construction phase;
 - .3 complete system checks and "fine tuning" with signed documentation as follows:
 - .1 once during 1st month of building operation;
 - .2 once during 3rd month of building operation;
 - .3 once between 4th and 10th months in a season opposite to 1st and 3rd month visits.
 - .4 correct deficiencies revealed by system checks described above, and, where required, involve equipment manufacturers/suppliers during corrective actions, and report completion of corrective work;
 - .5 3 months after Substantial Completion conduct a question and answer session(s) at building with Owner's operating and maintenance personnel, with duration of session(s) dictated by number of questions and concerns that have to be addressed.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 DEFINITIONS

- .1 "Agency" – means agency to perform testing, adjusting and balancing work.
- .2 "TAB" – means testing, adjusting and balancing to determine and confirm quantitative performance of equipment and systems and to regulate specified fluid flow rate and air patterns at terminal equipment, e.g., reduce fan speed, throttling, etc.
- .3 "hydronic systems" – includes heating water, chilled water, glycol-water solution, condenser water, and any similar system.
- .4 "air systems" – includes outside air, supply air, return air, exhaust air, and relief air systems.
- .5 "flow rate tolerance" – means allowable percentage variation, minus to plus, of actual flow rate values in Contract Documents.
- .6 "report forms" – means test data sheets arranged for collecting test data in logical order for submission and review, and these forms, when reviewed and accepted, should also form permanent record to be used as basis for required future testing, adjusting and balancing.
- .7 "terminal" – means point where controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- .8 "main" – means duct or pipe containing system's major or entire fluid flow.
- .9 "submain" – means duct or pipe containing part of the systems' capacity and serving 2 or more branch mains.
- .10 "branch main" – means duct or pipe servicing 2 or more terminals.
- .11 "branch" – means duct or pipe serving a single terminal.

1.3 QUALITY ASSURANCE

- .1 Employ services of an independent testing, adjusting, and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance building mechanical systems to produce design objectives. Agency is to have successfully completed testing, adjusting and balancing of mechanical systems for a minimum of 5 projects similar to this Project within past 3 years, and is to be certified as an independent agency in required categories by one of following:
- .1 AABC - Associated Air Balance Council;
- .2 NEBB - National Environmental Balancing Bureau.
- .2 Testing, adjusting and balancing of complete mechanical systems is to be performed over entire operating range of each system in accordance with 1 of following publications:
- .1 National Standards for a Total System Balance published by Associated Air Balance Council;

- .2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by National Environmental Balancing Bureau;
- .3 Chapter 37, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

1.4 SUBMITTALS

- .1 Within 30 days of work commencing at site, submit name and qualifications of proposed testing and balancing agency in accordance with requirements of article entitled Quality Assurance below.
- .2 Submit sample test forms, if other than those standard forms prepared by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB), are proposed for use.
- .3 Submit a report by Agency to indicate Agency's evaluation of mechanical drawings with respect to service routing and location or lack of balancing devices. Include set of drawings used and marked-up by Agency to prepare report.
- .4 Submit a report by Agency after each site visit made by Agency during construction phase of this Project.
- .5 Submit a draft report, as specified in Part 3 of this Section.
- .6 Submit a final report, as specified in Part 3 of this Section.
- .7 Submit a testing and balancing warranty as specified in Part 3 of this Section.
- .8 Submit reports listing observations and results of post construction site visits as specified in Part 3 of this Section.

2. Products

NOT USED

3. Execution

3.1 SCOPE OF WORK

- .1 Perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of fluid quantities of mechanical systems as required to meet design specifications and comfort conditions, and recording and reporting results.
- .2 Mechanical systems to be tested, adjusted and balanced include:
 - .1 TAB of domestic water systems (all piping extended from Municipal main) is to include:
 - .1 domestic hot water recirculation piping;
 - .2 tempered water piping flows.
 - .2 TAB of heating systems is to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
 - .3 TAB of cooling systems is also to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during cooling season, a follow-up site visit during cooling season will be required to confirm proper flows and temperatures, and any required system "fine".

- .4 TAB of air handling systems is to include equipment and ductwork air temperatures, capacities and flows.

3.2 TESTING, ADJUSTING AND BALANCING WORK

.1 Conform to following requirements:

- .1 as soon as possible after award of Contract, Agency is to carefully examine a white print set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing results of the evaluation;
- .2 set of drawings examined by Agency is to be returned with evaluation report, with red line mark-ups to indicate locations of readings, and required revision work such as relocation of balancing devices and locations for additional devices;
- .3 after review of mechanical work drawings and specification, Agency is to visit site at frequent, regular intervals during construction of mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting and balancing;
- .4 after each site visit, Agency is to report results of site visit indicating date and time of visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing;
- .5 testing, adjusting and balancing is not to begin until:
 - .1 building construction work is substantially complete and doors have been installed;
 - .2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.
- .6 mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting and balancing;
- .7 obtain copies of reviewed shop drawings of applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;
- .8 Agency is to walk each system from system "head end" equipment to terminal units to determine variations of installation from design, and system installation trades will accompany Agency;
- .9 Agency is to check valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;
- .10 wherever possible, Agency is to lock balancing devices in place at proper setting, and permanently mark settings on devices;
- .11 for belt-driven equipment, Agency is to report to Commissioning Agent who in turn is to inform Contractor and Consultant of any situation where sheaves have to be replaced to suit testing and balancing, and replacements are to be done by Contractor at no cost;
- .12 Agency is to leak test ductwork as specified in Section entitled HVAC Air Distribution in accordance with requirements of SMACNA "HVAC Air Duct Leak Test Manual", coordinate work with work of aforementioned Sections, provide detailed sketch(es) to Sheet Metal Contractor and Consultant identifying ductwork not in accordance with acceptable leakage values specified in aforementioned Sections, and retest corrected ductwork;
- .13 Agency is to balance systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at design conditions, Agency is to immediately report problem and submit data, including sound readings, to permit an accurate assessment of noise problem to be made;
- .14 Agency is to check supply air handling system mixing plenums for stratification, and where variation of mixed air temperature across coils is found to be in excess of $\pm 5\%$ of design requirements, Agency is to report problem and issue a detail sketch of plenum baffle(s) required to eliminate stratification;
- .15 Agency is to perform testing, adjusting and balancing to within $\pm 5\%$ of design values, and make and record measurements which are within $\pm 2\%$ of actual values;

- .16 for air handling systems equipped with air filters, test and balance systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;
- .2 Prepare reports as indicated below.
 - .1 Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in same manner specified for final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
 - .2 Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. Use units of measurement (SI or Imperial) as used on Project Documents.
 - .3 Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, 3-ring binders. Provide binding edge labels with project identification and a title descriptive of contents. Divide contents of binder into divisions listed below, separated by divider tabs:
 - .1 General Information and Summary;
 - .2 Air Systems;
 - .3 Hydronic Systems;
 - .4 Agency is to provide following minimum information, forms and data in report:
 - .1 inside cover sheet to identify Agency, Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of instrumentation used for procedures along with proof of calibration;
 - .2 remainder of report is to contain appropriate forms containing as a minimum, information indicated on standard AABC or NEBB report forms prepared for each respective item and system;
 - .3 Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories;
 - .4 Agency is to include report sheets indicating building comfort test readings for all rooms.
- .3 After final testing and balancing report has been submitted, Agency is to visit site with Contractor and Consultant to spot check results indicated on balancing report. Agency is to supply labour, ladders, and instruments to complete spot checks. If results of spot checks do not, on a consistent basis, agree with final report, spot check procedures will stop and Agency is to then rebalance systems involved, resubmit final report, and again perform spot checks with Contractor and Consultant.
- .4 When final report has been accepted, Contractor is to submit to Owner, in name of Owner, a certificate equal to AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, Contractor is to submit a written extended warranty from Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by Agency and reported on to Owner, and if it is determined that problems are a result of improper testing, adjusting and balancing, they are to be immediately corrected without additional cost to Owner.

- .5 Do not begin testing, adjusting and balancing work until:
 - .1 building construction work is substantially complete;
 - .2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then performance tested in the presence of and to the satisfaction of the Consultant;
 - .3 the mechanical systems have been prepared for testing and balancing work.
- .6 All mechanical systems to be tested, adjusted and balanced must be maintained in full, normal operation during each day of testing, adjusting and balancing.
- .7 Perform testing, adjusting and balancing to within plus or minus 5% of design values, and make and record measurements using instruments with minimum accuracy of within plus or minus 2% of required values.
- .8 Wherever possible, lock all balancing devices in place at the proper setting, and permanently mark settings on all devices.
- .9 Co-operate and work with the controls contractor in the verification of the operation of all systems.

3.3 TESTING, ADJUSTING AND BALANCING REPORT

- .1 Prepare and submit to the Consultant, when the work is complete, bound, identified copies of a testing and balancing report as specified in the article entitled "SUBMITTALS" in PART 1 of this Section. Prepare the report using standard AABC, NEBB or equal forms to indicate all measurements required by the referenced balancing standard, including, but not limited to, the following:
 - .1 Cooling system c/w location of equipment (e.g. chiller, pumps), measurements at inlet and outlet of equipment;
 - .2 Air handling system c/w location of equipment and measurements at the inlet and outlet of exhaust fan.
- .2 Include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "As-built" diagram indicating all equipment and accessories.
- .3 Prepare report sheets using the units of measurement (SI or Imperial) as used on the project construction documents.

3.4 VERIFICATION OF TESTING, ADJUSTING AND BALANCING REPORT

- .1 When the testing, adjusting and balancing report has been received, the Consultant will schedule a site visit or visits for the purpose of verifying balancing results contained in the report. In addition to spot checking equipment performance, a maximum of 30% of all terminal equipment will be checked.
- .2 The testing and balancing agency shall accompany the Consultant during report verification, and shall supply all required tools and instruments to take measurements. Instruments used shall be the same instruments used in performing the testing and balancing work.
- .3 If, during the verification procedures, testing and balancing results indicated in the report are found to differ substantially with the results of spot checks, the report will be rejected by the Consultant, and testing, adjusting and balancing procedures shall be repeated and a new report issued for review and verification.
- .4 Testing, adjusting and balancing must be complete and accepted by the Consultant prior to application for a Certificate of Substantial Performance of the Work.

- .5 Include a copy of the accepted testing and balancing report in each copy of the operating and maintenance instruction manuals.

3.5 WARRANTY

- .1 When testing, adjusting and balancing work is complete and the balancing report has been accepted, submit to the Project Manager, in the name of the Owner, an AABC National Guaranty Certification or NEBB Certificate of Conformance Certification, as applicable, and in addition, submit to the Project Manager, in the name of the Owner, a written extended warranty covering one (1) full heating season and one (1) full cooling season, during which time any balancing problems which occur in the building, with the exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by your personnel and reported on to the Project Manager. If it is determined that the problems are a result of improper testing, adjusting and balancing, they shall be immediately corrected without additional cost to the Owner.

END OF SECTION

1 General

1.1 APPLICATION

- .1 This Section specifies firestopping and smoke seal requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 SUBMITTALS

- .1 At least 4 weeks prior to work commencing, submit a sample of each type of material requirements for firestop and smoke seal systems in applied form. Identify each system with manufacturer's name and type, ULC designation, and proposed use. After samples are reviewed, work is to conform to reviewed samples.
- .2 Submit a product data sheet and a WHIMIS sheet for each firestopping and smoke seal product.
- .3 Submit for review, full company name and experience of proposed firestopping and smoke seal system applicator.
- .4 Submit a letter of proper firestopping and smoke seal certification as specified in Part 3 of this Section.

1.3 QUALITY ASSURANCE

- .1 Applicator is to have a minimum of 3 years of successful experience on projects of similar size and complexity, and is to be reviewed by Consultant.
- .2 Comply with firestopping and smoke seal product manufacturer's recommendations regarding suitable environment conditions for product installation.

2 Products

2.1 FIRESTOPPING AND SMOKE SEAL SYSTEM MATERIALS

- .1 Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with ULC S115 and ULC S101 for installation in ULC designated firestopping and smoke seal systems to provide a positive fire, water and smoke seal, and a fire-resistance rating (flame, hose stream and temperature) not less than fire resistance rating of surrounding fire rated construction.
- .2 Firestopping and smoke seal material system to be specifically ULC certified with designated reference number for its specific installation. As part of shop drawing submission, submit copies of firestopping drawings with ULC certificate and system number for each specific installation.
- .3 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer's recommendations and ULC tested assembly. Coordinate material requirements with trades supplying abutting areas of materials.
- .4 Typically, for openings of up to 250 mm (10") in diameter, provide putty pad type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibres or silicone compounds.

- .5 Typically, for openings of greater than 250 mm (10") in diameter, and for rectangular openings, provide pillow type firestop materials equivalent to Specified Technologies Inc. "SpecSeal" re-enterable, non-curing, mineral fibre core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag.
- .6 Pipe insulation forming part of a fire and smoke seal assembly is specified in Section entitled Mechanical Insulation.
- .7 Supply products of a single manufacturer for use on work of this Division.
- .8 Installer to be manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.
- .9 Include for manufacturer's authorized representative to inspect and verify each installation and application. Submit test report signed and verified by system installer's authorized representative and manufacturer's representative.
- .10 Acceptable certification to also include certification by Underwriters Laboratories of Northbrook IL, using tests conforming to ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".
- .11 Acceptable manufacturers are:
 - .1 Specified Technologies Inc.;
 - .2 3M Canada Inc.;
 - .3 Tremco;
 - .4 A/D Fire Protection Systems;
 - .5 Nelson;
 - .6 Hilti Canada.

3 Execution

3.1 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Where work penetrates or punctures fire rated construction, provide ULC certified, listed and labelled firestopping and smoke sealing packing material systems to seal openings and voids around and within raceway and to ensure that continuity and integrity of fire separation is maintained. Openings not in immediate vicinity of working areas are to be firestopped and sealed same day as being opened.
- .2 Install firestopping and smoke seal materials for each installation in strict accordance with specific ULC certification number and manufacturer's instructions. Comply with local governing building code requirements and obtain approvals from local building inspection department. Ensure that openings through fire separations do not exceed maximum size wall opening, and maximum and minimum dimensions indicated in ULC Guide No. 40 U19 for Service Penetration Assemblies and firestopping materials.
- .3 Ensure that continuity and integrity of fire separation is maintained and conform to requirements of latest edition of ULC publication "List of Equipment and Materials, Volume II, Building Construction".
- .4 Comply with following requirements:
 - .1 Examine substrates, openings, voids, adjoining construction and conditions under which firestop and smoke seal system is to be installed. Confirm compatibility of surfaces.
 - .2 Verify penetrating items are securely fixed and properly located with proper space allowance between penetrations and surfaces of openings.

- .3 Report any unsuitable or unsatisfactory conditions to Consultant in writing, prior to commencement of work. Commencement of work will mean acceptance of conditions and surfaces.
 - .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces. Remove stains on adjacent surfaces.
 - .5 Prime substrates in accordance with product manufacturer's written instructions.
 - .6 Provide temporary forming as required and remove only after materials have gained sufficient strength and after initial curing.
 - .7 Tool or trowel exposed surfaces to a neat, smooth, and consistent finish.
 - .8 Remove excess compound promptly as work progresses and upon completion.
 - .9 At fusible link damper locations, seal perimeter of angle iron framing on both sides of wall or slab with ULC listed and labelled sealant materials to provide a positive smoke seal.
- .5 Notify Consultant when work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies. Arrange for final inspection of work by local governing authority inspector prior to concealing or enclosing work. Make any corrections required.
- .6 On completion of firestopping and smoke sealing installation, submit a Letter of Assurance to Consultant certifying the firestopping and smoke sealing installation has been carried out throughout the building to service penetrations and that installation has been performed in strict accordance with requirements of local governing building code, any applicable local municipal codes, ULC requirements, and manufacturer's instructions.
- .7 Manufacturer's authorized representative to inspect and verify each installation and provide a test report signed by installing trade and manufacturer's representative. Test report to list each installation and respective ULC certification and number.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe, fittings, and chlorine.
- .2 Submit laboratory water purity test results indicating chlorine residual prior to application for Substantial Performance of the Work.
- .3 Prior application for Substantial Performance of the Work, submit a minimum of 3 identified keys for key operated hydrants.
- .4 Submit signed test results and inspection and test log cards for each backflow preventer as specified in Part 3 of this Section.
- .5 Submit anchor drawing(s) to detail fabrication and installation of water piping anchors. Drawing(s) are to be prepared and stamped by a professional structural engineer registered and licensed in jurisdiction of the work.
- .6 As specified in Part 3 of this Section, submit a letter from anchor design engineer stating anchor installation has been examined at site and anchors are properly fabricated and installed.

1.02 QUALITY ASSURANCE

- .1 Domestic water piping and valves are to comply with following codes, regulations and standards (as applicable):
 - .1 applicable local codes and regulations;
 - .2 ASTM F1960, Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing;
 - .3 CAN/CSA B125.1, Plumbing Supply Fittings;
 - .4 CAN/CSA B125.3, Plumbing Fittings;
 - .5 CAN/CSA B137 Series, Thermoplastic Pressure Piping Compendium;
 - .6 CAN/ULC S102.2, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies;
 - .7 CAN/ULC S101, Fire Endurance Tests of Building Construction and Materials;
 - .8 NSF/ANSI 14, Plastics Piping System Components and Related Materials;
 - .9 NSF/ANSI 61, Drinking Water System Components – Health Effects;
 - .10 NSF/ANSI 372, Drinking Water System Components – Lead Content.

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

.1 PVC

- .1 ULC listed, rigid, Class 150, DR18, 1035 kPa (150 psi) pressure rated bell and spigot pattern PVC pipe to CAN/CSA B137.3, and CSA certified fittings to CAN/CSA B137.2, and AWWA C900, complete with gasket joints, and Ford "Uni-Flange" or equal restraint collars as per Part 3 of this Section.

.2 Soft Copper

- .1 Type "K" soft copper to ASTM B88, supplied in a continuous coil with no joints if possible, and complete with, if joints are required, compression type flared joint couplings.

.3 Stainless Steel

- .1 Schedule 10S type 304 stainless steel, ASTM A312, factory or site roll grooved, complete with Victaulic or equal type 304 stainless steel roll grooved end fittings and, unless otherwise specified, Victaulic Style 489 or equal lightweight rigid type 304L stainless steel couplings and coupling gaskets equal to Victaulic Grade E or Grade M.

.4 Hard Copper - Solder Joint

- .1 Type "L" hard drawn seamless copper to ASTM B88, complete with copper solder type fittings to ASME/ANSI B16.18 and soldered joints using The Canada Metal Co. Ltd. "SILVABRITE 100" or equal lead-free solder for cold water pipe, and 95% tin/ 5% Antimony or "SILVABRITE 100" solder for other services.

.5 Semi-Rigid Polyethylene Tubing

- .1 Versa Fittings and Mfg. Inc. 12 mm (½") dia., high density, semi-rigid polyethylene tubing, 1380 kPa (200 psi) rated.

2.02 SHUT-OFF VALVES

.1 Ball Valves

- .1 Class 600, 4140 kPa (600 psi) WOG rated, lead-free, full port ball type valves, each complete with a forged brass body with solder ends, forged brass cap, blowout-proof stem, solid forged brass chrome plated ball, "Teflon" or "PTFE" seat, and a removable lever handle. Valves in insulated piping are to be complete with stem extensions.

.2 Acceptable products are:

- .1 Toyo Valve Co. Fig. 5049A-LF;
- .2 Milwaukee Valve Co. #UPBA485B;
- .3 Kitz Corporation Code 859;

- .4 Apollo Valves #77LF-200;
- .5 Watts Industries (Canada) Inc. #LFFBVS-3C.
- .2 Butterfly Valves - Flanged Joint
 - .1 Non-corrosive, minimum 1200 kPa (175 psi) cold water pressure rated, resilient seated butterfly valves, each complete with a coated cast ductile iron lug type body, stainless steel shaft, bronze disc, and EPDM seat, and each suitable for domestic water bubble-tight dead end service with valve in position and either side of connecting piping removed. Butterfly valves to and including 100 mm (4") dia. are to be equipped with lever handles. Butterfly valves larger than 100 mm (4") dia. are to be equipped with worm gear operators.
 - .2 Acceptable products are:
 - .1 DeZurik #632L Series;
 - .2 Kitz Corporation Code #6122EL/EG;
 - .3 Toyo Valve Co. #918BESL/EG;
 - .4 Bray Valve and Controls Canada Series 31;
 - .5 Apollo Valves #141 Series;
 - .6 Watts Industries (Canada) Inc. #BF-03.

2.03 CHECK VALVES

- .1 Horizontal
 - .1 Lead-free, Class 125, bronze, 1380 kPa (200 psi) WOG rated horizontal swing type check valves with solder ends.
 - .2 Acceptable products are:
 - .1 Toyo Valve Co. Fig. 237A-LF;
 - .2 Milwaukee Valve Co. #UP1509;
 - .3 Kitz Corporation Code 823;
 - .4 Apollo Valves #61LF Series.
- .2 Vertical
 - .1 Equal to Kitz Corp. Code 826, lead-free, 1725 kPa (250 psi) WOG rated vertical lift check valve with soldering ends.

2.04 DRAIN VALVES

- .1 Minimum 2070 kPa (300 psi) water rated, 20 mm (¾") dia., straight pattern full port bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm (¾") dia. garden hose, and a cap and chain.

.2 Acceptable products are:

- .1 Toyo Valve Co. Fig. 5046;
- .2 Dahl Brothers Canada Ltd. Fig. No. 50. 430;
- .3 Kitz Corporation Code 58CC;
- .4 Apollo Valves #78-104-01;
- .5 Watts Industries (Canada) Inc. #B6000.

2.05 DOMESTIC HOT WATER PIPING BALANCING VALVES

- .1 Solder or flanged end type as required, globe style, non-ferrous circuit balancing valves designed to facilitate precise flow measurement, precision flow balancing, and positive shut-off, complete with capped and valved drain connection, and valved ports for connection to a differential pressure meter.
- .2 Acceptable products are:
 - .1 S.A. Armstrong Model CBV Series;
 - .2 Tour and Andersson Model TBV Series;
 - .3 Watts Industries (Canada) Inc. Model CSM Series.

2.06 DOMESTIC HOT WATER THERMOSTATIC MIXING VALVES

- .1 Lawler Manufacturing Co. Inc. 800 Series "High-Low Thermostatic Mixer" factory assembled rough bronze thermostatic mixing valve assembly complete with rotatable union end inlet piping with check stops and stainless steel strainer screens, union outlet piping with thermometer connection, all sized as shown, and following:
 - .1 mixing valve with liquid motor, stainless steel piston and liner, tamper-resistant control adjustment, and 3-way protection against runaway temperatures, thermal shock, and scalding;
 - .2 dial type thermometer conforming to requirement specified in Section entitled Basic Mechanical Materials and Methods;
 - .3 ball type outlet shut-off valve conforming to valve requirements specified in this Section;
- .2 Acceptable manufacturers are:
 - .1 Lawler Manufacturing Co. Inc.;
 - .2 Symmons Industries Inc.

2.07 CHLORINE

- .1 Sodium hypochlorite to AWWA B300.

2.08 FLOOR DRAIN TRAP SEAL PRIMERS

- .1 Primer Valve Type
 - .1 Precision Plumbing Products Inc. Model P2-500 trap primer valve, constructed of brass, adjustable to high or low water pressures and complete with "O" ring seals, 12 mm (½") threaded inlet and outlet connections, and, for priming two traps from the same primer, a DU-2 dual outlet distribution unit.
- .2 Primer Valve Type with Manifold
 - .1 Precision Plumbing Products Inc. Model P1-500 trap primer valve constructed as specified above for the Model P2-500 primer valve, complete with a Model DU-3 or DU-4, 3 or 4 outlet distribution unit for priming 3 or 4 traps, and at Model "YS-8" supply tube with combinations of Model DU-3 and DU-4 distribution units for priming from 5 to 6 traps.
- .3 Electronic Type
 - .1 Precision Plumbing Products #PT Series surface wall mounting, CSA certified, 115 volt, 1-phase, 60 Hz., electronic, automatic trap priming manifolds, each sized to suit the number of drain traps or interceptors serviced, and each complete with:
 - .1 galvanized steel cabinet with door;
 - .2 20 mm (¾") dia. NPT copper pipe inlet with shut-off valve and water hammer arrestor;
 - .3 solenoid valve, an atmospheric vacuum breaker, and a discharge manifold with 12 mm (½") dia. compression type copper tube connections on 40 mm (1-½") centres with quantity to suit the number of items to be primed;
 - .4 control panel with circuit breaker, 5 ampere fuse, 24 hour timer, and manual override toggle switch.

2.09 SHOCK ABSORBERS

- .1 Type 304 stainless steel piping shock absorbers, each complete with a nesting type bellows and a casing of sufficient displacement volume to dissipate kinetic energy generated in piping system, and each sized to suit connecting potable water pipe and equipment it is provided for.
- .2 Acceptable products are:
 - .1 Watts Industries (Canada) Inc. "SG" Series;
 - .2 Jay R. Smith 5000 Series "HYDROTROL";
 - .3 Zurn #Z1700 "SHOKTROL";
 - .4 Mifab "HAMMERGUARD" WHB Series.

2.10 WATER HAMMER ARRESTORS

- .1 Piston type, sealed, all stainless steel construction, pressurized water hammer arrestors suitable for either vertical or horizontal installation, each complete with a pressurized compression chamber, welded nesting-type expansion bellows surrounded by non-toxic mineral oil, and a male treaded nipple connection.
- .2 Acceptable products are:
 - .1 Jay R. Smith 5000 Series;
 - .2 Precision Plumbing Products "SS" Series.

2.11 AIR VENTS

- .1 Equal to ITT Hoffman Specialty No. 78 cast brass, 1035 kPa (150 psi) rated, 20 mm ($\frac{3}{4}$ ") straight water main vent valves, each tapped at the top for a 3.2 mm ($\frac{1}{8}$ ") safety drain connection.

3 EXECUTION

3.01 PIPING INSTALLATION REQUIREMENTS

- .1 Provide required domestic water piping.
- .2 Piping, unless otherwise specified, is as follows:
 - .1 for underground piping 100 mm (4") dia. and larger outside and/or inside the building – rigid PVC;
 - .2 for underground piping less than 100 mm (4") dia. inside building – Type "K" soft copper;
 - .3 for pipe 100 mm (4") dia. and larger inside building and above ground – Schedule 10 stainless steel;
 - .4 for 12 mm ($\frac{1}{2}$ ") dia. trap seal primer tubing located underground or in concrete or masonry construction – semi-rigid polyethylene;
 - .5 for pipe inside building and aboveground in sizes to 100 mm (4") dia. – Type "L" hard copper with solder joints
- .3 Brace and secure underground water service pipe at bends, tees and similar fittings with restraint devices, and provide concrete thrust blocks in accordance with Municipal standards and details. Regardless of what is specified elsewhere in this Specification regarding provisions of concrete, provide thrust block concrete. Paint restraint devices with 2 coats of corrosion resistant black asphalt base coating prior to backfilling.
- .4 Lay pipes true to line and grade with bells up/grade. Fit sections together so that, when complete, pipe has a smooth and uniform invert. Keep pipe thoroughly clean so jointed compound will adhere. Inspect pipe for defects before being lowered into trench.
- .5 Slope piping so it can be completely drained.

- .6 Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe or equipment.

3.02 INSTALLATION OF SHUT-OFF AND CHECK VALVES

- .1 Refer to Part 3 of Section entitled Basic Mechanical Materials and Methods.
- .2 For shut off valves installed on solder joint copper piping up to and including 75 mm (3") diameter, provide ball type valves, and for flanged joints copper or stainless steel piping larger than 75 mm (3") diameter provide butterfly type valves.

3.03 INSTALLATION OF DRAIN VALVES

- .1 Provide a drain valve at the bottom of domestic water piping risers, at other piping low points, and wherever else shown.
- .2 Locate drain valves so they are easily accessible.

3.04 INSTALLATION OF DOMESTIC HOT WATER PIPING BALANCING VALVES

- .1 Provide balancing valves in domestic hot water recirculation piping where shown or required.
- .2 Locate each valve so it is easily accessible.

3.05 INSTALLATION OF PRESSURE REDUCING VALVES

- .1 Provide domestic water pressure reducing valves. Install so each valve is readily accessible. Whenever possible, provide pressure reducing valves factory pre-set to required pressures.
- .2 Check and test operation, and adjust as required.

3.06 INSTALLATION OF DOMESTIC HOT WATER THERMOSTATIC MIXING VALVES

- .1 Provide a domestic hot water thermostatic mixing valve assembly and wall mount.
- .2 Adjust each valve to design requirements and check and test operation. Set maximum temperature limit stops.
- .3 Identify each valve and its water temperature delivery setting with an engraved nameplate.

3.07 INSTALLATION OF TRAP SEAL PRIMERS

- .1 Provide required accessible trap seal primers to automatically maintain a water seal in floor drain traps, whether shown on drawings or not.
- .2 Water closet flush valves may be used for priming washroom floor drain traps if flush tube is properly tapped and primer tubing exposed in washroom is chrome plated.
- .3 Provide trap primer valves to prime single or multiple (1 to 6) traps. Install trap primer valves in domestic cold water piping to frequently used plumbing fixtures. Where from 2 to 6 traps are to be primed from same primer valve, provide appropriate supply and distribution tube assemblies. Ensure primer valves are accessible.

- .4 Provide 115 volt, electronic, surface wall mounting trap primer assemblies for multiple (4 to 30) traps. Include for a 115 volt 15 ampere panel breaker and wiring in conduit from closest panelboards to primer assembly, all to wiring standards of Electrical Division. Adjust primer water flow and timing to suit number of traps served.
- .5 Ensure trap primer piping is secured to floor drain primer tapplings and not terminated through the tapping in the throat of the drain.

3.08 INSTALLATION OF SHOCK ABSORBERS

- .1 Provide accessible shock absorbers in domestic water piping.
- .2 Ensure size of each shock absorber is properly selected to suit size of domestic water pipe and equipment pipe is connected to.

3.09 INSTALLATION OF WATER HAMMER ARRESTORS

- .1 Provide accessible water hammer arrestors in domestic water piping in locations as follows:
 - .1 in headers at groups of plumbing fixtures;
 - .2 at top of risers;
 - .3 at ends of long horizontal runs of piping;
 - .4 in piping connecting solenoid valves or equipment with integral solenoid valves;
 - .5 wherever else shown or required by Code.
- .2 Install each unit in a piping tee either horizontally or vertically in the path of potential water shock in accordance with manufacturer's instructions and details.

3.10 INSTALLATION OF AIR VENTS

- .1 Provide accessible air vents in domestic water piping to prevent air binding.
- .2 Extend copper indirect drain piping from top drain connection of each vent to nearest suitable drain.
- .3 Locate exact vent locations on as-built record drawings.

3.11 FLUSHING AND DISINFECTING PIPING

- .1 Flush and disinfect all new and/or reworked domestic water piping after leakage testing is complete.
- .2 Flush piping until all foreign materials have been removed and flushed water is clear. Provide connections and pumps as required. Open and close valves, faucets, hose outlets, and service connections to ensure thorough flushing.
- .3 When flushing is complete, disinfect the piping with a solution of chlorine in accordance with AWWA C601.

- .4 When disinfecting is complete, submit water samples to a certified laboratory for purity testing and, when testing indicates pure water in accordance with governing standards, submit a copy of test results and fill the systems.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings.
- .2 Submit a copy of plumbing inspection certificate prior to application for Substantial Performance of the Work.
- .3 Submit letters from product manufacturers/suppliers to certify correct installation of products as specified in Part 3 of this Section.

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

- .1 PVC Sewer
 - .1 DR35 rigid, green PVC hub and spigot pattern sewer pipe and fittings to CAN/CSA B182.2, with gasket joints assembled with pipe lubricant.
 - .2 DR35 rigid, PVC sewer pipe and fittings, with solvent weld joints, all certified to CSA B182.1 and colour-coded as per local governing codes, regulations and standards.
- .2 Copper - Solder Joint
 - .1 Type DWV hard temper to ASTM B306, with forged copper solder type drainage fittings and 50% lead - 50% tin solder joints.
- .3 Cast Iron
 - .1 Class 4000 cast iron pipe, fittings, and mechanical coupling joints to CAN/CSA B70.
- .4 Copper - Victaulic Coupling Joint
 - .1 Type DWV hard temper to ASTM B306, with factory or site rolled grooved ends (with grooving rolls designed for copper) and Victaulic "Copper Connection" wrought
- .5 Galvanized Steel - Victaulic Coupling Joint
 - .1 Schedule 40 mild steel, galvanized, ASTM A53, factory or site rolled grooved, complete with Victaulic galvanized ductile iron grooved end fittings and, unless otherwise specified, Victaulic Style 77 hot dip galvanized mechanical joint couplings with Grade M gaskets.
- .6 PVC Weeper Piping
 - .1 150 mm (6") dia. corrugated perforated PVC pipe with an integral geodesic sock, supplied in coils.

2.02 SHUT-OFF AND CHECK VALVES

.1 Shut-off Valves

- .1 Class 600, 4140 kPa (600 psi) WOG rated full port ball valves, each complete with a forged brass body, blowout-proof stem, chrome plated solid brass ball, solder or screwed ends as required, and removable lever handle.
- .2 Acceptable products are:
 - .1 Toyo Valve Co. Fig. 5049A or Fig. 5044A;
 - .2 Milwaukee Valve Co. #BA-155 or #BA -125;
 - .3 Kitz Corporation Code 58 or Code 59;
 - .4 Victaulic Co. of Canada Ltd. Series 722;
 - .5 Apollo Valves # 77-100 or # 77-200;
 - .6 Watts Industries (Canada) Inc. #FBVS-3C.

.2 Check Valves

- .1 Class 125, bronze, 1725 kPa (250 psi) WOG rated vertical lift check valve with solder or screwed ends as required, and, for horizontal piping, Class 125, bronze 1380 kPa (200 psi) WOG rated swing check valves with solder or screwed ends.
- .2 Acceptable products are:
 - .1 Toyo Valve Co. Fig. 231 or Fig. 236 or Fig. 237;
 - .2 Milwaukee Valve Co. #1510 or #510;
 - .3 Kitz Corporation Code 36 or Code 22 or Code 23.

2.03 VENT STACK COVERS

- .1 Equal to Lexcor Model "Flash-Tite" seamless, spun aluminum, insulated vent stack covers with caps and a factory applied asphalt primer coating on top and bottom of flange.
- .2 Each vent stack cover is to be complete with a vandal-proof cap.

2.04 CLEANOUTS

.1 Horizontal Piping

- .1 TY pipe fitting with an extra heavy brass plug screwed into the fitting.

.2 Vertical Piping

- .1 Bronze or copper cleanout tees in copper piping, each complete with a bronze ferrule, and, for cast iron piping, "BARRETT" type cast iron cleanout tees, each gas and water-tight and complete with a bolted cover.

.3 Urinal(s)

- .1 Wall access cleanout assemblies, each complete with a tapered plug, threaded brass insert, urethane rubber seal, and polished stainless steel access cover with vandal-proof stainless steel securing screw.
- .2 Acceptable products are:
 - .1 Watts Industries (Canada) Ltd. #CO-590-RD;
 - .2 Jay R. Smith #SQ4-1819;
 - .3 Zurn #ZSS-1666-1;
 - .4 Mifab #C1440-RD.

2.05 FLOOR CLEANOUT TERMINATIONS

- .1 Factory finished cast iron terminations, each adjustable and complete with a cast iron body with neoprene sleeve, solid, gasketed, polished nickel-bronze scoriated top access cover to suit floor finish, a seal plug, and captive, vandal-proof, stainless steel securing hardware.
- .2 Acceptable products are:
 - .1 Watts Industries (Canada) Ltd. # CO-200-R-1;
 - .2 Jay R. Smith #4020-F-C Series;
 - .3 Zurn # ZN-1602-SP Series;
 - .4 Mifab # C1100-XR-1 or #C1000-R-3.
- .3 Cleanout terminations in areas with a tile or sheet vinyl floor finish are to be as above but with a square top in lieu of a round top.

2.06 FLOOR DRAINS, FUNNEL FLOOR DRAINS AND HUB DRAINS

- .1 Unless otherwise specified or indicated, floor drains are to be vandal-proof drains in accordance with drawing symbol list, each complete with a cast iron body and a trap seal primer connection. Cast iron components are to be factory finished with latex based paint coating.
- .2 Floor drains in areas with a tile or sheet vinyl floor finish are to be as above but with a square grate in lieu of a round grate.
- .3 Acceptable manufacturers are:
 - .1 Watts Industries (Canada) Ltd.;
 - .2 Jay R. Smith Manufacturing Co.;
 - .3 Zurn Industries Ltd.;
 - .4 Mifab Inc.

2.07 ROOF DRAINS

- .1 Unless otherwise specified or indicated, roof drains are to be cast iron body drains with aluminium domes, in accordance with the drawing symbol list. Cast iron components are to be factory finished with latex based paint coating.
- .2 Acceptable manufacturers are:
 - .1 Watts Industries (Canada) Ltd.;
 - .2 Jay R. Smith Manufacturing Co.;
 - .3 Zurn Industries Ltd.;
 - .4 Mifab Inc.

2.08 TRENCH DRAINS

- .1 Modular, pre-sloped, polyester fibreglass construction interlocking sections of drainage channel with overlapping joints, drain pipe connection outlets as required, end caps and covers to suit the application, integral anchor tabs for grate anchoring and trench levelling, heavy-duty coated steel angle top frames, and heavy-duty coated cast iron slotted grate supplied in 600 mm (24") long sections.
- .2 Acceptable products are:
 - .1 Watts Industries (Canada) Inc. "Dead Level" Series;
 - .2 Jay. R. Smith #9810 Series;
 - .3 Zurn "Flow-Thru" System;
 - .4 ACO Systems Ltd. "ACOdrain".

2.09 BACKWATER VALVES

- .1 Backwater valve shall be modified to be of normally open design.
- .2 Acceptable products are:
 - .1 Mainline

3 EXECUTION

3.01 DRAIN AND VENT PIPING INSTALLATION REQUIREMENTS

- .1 Provide required drainage and vent piping. Pipe, unless otherwise specified, as follows:
 - .1 for underground pipe inside building and to points 1.5 m (5') outside building lines – rigid PVC sewer pipe, minimum 75 mm (3") dia.;
 - .2 for pipe inside building and aboveground in sizes less than or equal to 65 mm (2-½") dia. – type DWV copper;

- .3 for pipe inside building and aboveground in sizes greater than or equal to 75 mm (3") dia. – Class 4000 cast iron;
- .4 for drainage pump discharge pipe connections from pump to and including shut-off and check valve connections – Type "DWV" copper with Victaulic "Copper Connection" fittings and couplings, or Schedule 40 galvanized steel with Victaulic fittings and couplings.
- .2 Unless otherwise specified, slope horizontal drainage piping aboveground in sizes to and including 75 mm (3") dia. 25 mm (1") in 1.2 m (4'), and pipe 100 mm (4") dia. and larger 25 mm (1") in 2.4 m (8').
- .3 Install and slope underground drainage piping to inverts or slopes indicated on drawings to facilitate straight and true gradients between points shown. Verify available slopes before installing pipes.
- .4 Unless otherwise specified, slope horizontal branches of vent piping down to fixture or pipe to which they connect with a minimum pitch of 25 mm (1") in 1.2 m (4').
- .5 Extend vent stacks up through roof generally where shown but with exact locations to suit site conditions and in any case a minimum of 3 m (10') from fresh air intakes. Terminate vent stacks a minimum of 330 mm (13") above roof (including roof parapets) in vent stack covers. Where not shown on drawings, route vent piping from source to building exterior as required in order to satisfy local governing codes and authority. Coordinate vent routing with other building services and ensure there is no architectural impact.
- .6 Provide cast brass dielectric unions at connections between copper pipe and ferrous pipe or equipment.

3.02 INSTALLATION OF SHUT-OFF AND CHECK VALVES

- .1 Provide a shut-off valve and a check valve in discharge piping of each drainage pump.
- .2 Locate valves so they are easily accessible without the use of ladders or other such devices.

3.03 SUPPLY OF VENT STACK COVERS

- .1 Supply a properly sized vent stack cover for each vent stack penetrating roof.
- .2 Hand vent stack covers to roofing trade at site for installation and flashing into roof construction as part of roofing work. Coordinate installation to ensure proper locations. Provide waterproofing caps over vent stacks.

3.04 INSTALLATION OF CLEANOUTS

- .1 Provide cleanouts in drainage piping in locations as follows:
 - .1 in building drain or drains as close as possible to inner face of outside wall, and, if a building trap is installed, locate cleanout on downstream side of building trap;
 - .2 at or as close as practicable to the foot of each drainage stack;
 - .3 at maximum 15 m (50') intervals in horizontal pipe 100 mm (4") dia. and smaller;

- .4 at maximum 30 m (100') intervals in horizontal pipe larger than 100 mm (4") dia.;
 - .5 in the wall at each new urinal or bank of urinals in a washroom;
 - .6 wherever else shown on drawings.
- .2 Cleanouts are to be same diameter as pipe in piping to 100 mm (4") dia., and not less than 100 mm (4") dia. in piping larger than 100 mm (4") dia.
 - .3 Where cleanouts in vertical piping are concealed behind walls or partitions, install cleanouts near floor and so cover is within 25 mm (1") of the finished face of the wall or partition.

3.05 INSTALLATION OF FLOOR CLEANOUT TERMINATIONS

- .1 Where cleanouts occur in horizontal inaccessible underground piping, extend cleanout TY fitting up to floor, and provide a cleanout termination set flush with finished floor.
- .2 In waterproof floors, ensure each cleanout termination is equipped with a flashing clamp device. Cleanout terminations are to suit floor finish.
- .3 Where cleanout terminations occur in finished areas, confirm locations prior to rough-in and arrange piping to suit.
- .4 Ensure cleanout termination covers in tiled floor are square in lieu of round.

3.06 INSTALLATION OF FLOOR DRAINS, FUNNEL FLOOR DRAINS AND HUB DRAINS

- .1 Provide floor drains, funnel floor drains and hub drains.
- .2 Coordinate location of floor drains, funnel floor drains and hub drains with equipment provided by Mechanical Division and Owner's supplied equipment. Install in accordance with manufacturer's instructions.
- .3 Equip each drain with a trap.
- .4 In equipment rooms and similar areas, exactly locate floor drains to suit location of mechanical equipment and equipment indirect drainage piping. In washrooms, exactly locate floor drains to avoid interference with toilet partitions.
- .5 Confirm exact location of drains prior to roughing in. Where floor drains occur in washrooms coordinate locations with toilet partition installations.
- .6 Temporarily plug and cover floor drains during construction procedures. Remove plugs and covers during final clean-up work and when requested, demonstrate free and clear operation of each drain. Replace any damaged grates, and refinish any areas of the drain where cast iron finish has been damaged or removed, including rusted areas.

3.07 INSTALLATION OF ROOF DRAINS

- .1 Supply roof drains and place roof drain bodies in position for flashing into roof construction as part of roofing work. Connect with piping and provide accessories.

- .2 Protect roof drains from damage and entrance of debris until roofing work is complete, and refinish any areas where cast iron factory finish has been damaged or removed, including rusted areas.

3.08 INSTALLATION OF TRENCH DRAINS

- .1 Provide pre-sloped sections of drainage channel and install so top frames are level and plumb in relation to floor finishes. Provide accessories, traps, etc., as required.
- .2 Be present during concrete pour to ensure trench drainage is not dislodged or damaged and remains straight and true. Immediately report any problems.
- .3 Install grating and secure in place.
- .4 Temporarily cover trench drainage openings during construction procedures. Clean trenches when work is complete.

3.09 INSTALLATION OF BACKWATER VALVES

- .1 Provide backwater valves in drainage piping and connect with piping.
- .2 Set backwater valve assembly such that cover is flush with finished floor. Provide an extension piece if required due to depth of piping.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit product data sheets (fixture cuts) for all plumbing fixtures and fittings.

2 PRODUCTS

2.01 GENERAL RE: PLUMBING FIXTURES AND FITTINGS

- .1 Fixtures and fittings, where applicable, are to be in accordance with requirements of CAN/CSA B45 Series, General Requirements for Plumbing Fixtures, including supplements, ASME A112.1.18.1/CSA B125.1, Plumbing Supply Fittings, and CSA B125.3, Plumbing Fittings.
- .2 Barrier-free fixtures and fittings are to be in accordance with governing Code requirements.
- .3 Unless otherwise specified, vitreous china, porcelain enamelled, and acrylic finished fixtures are to be white.
- .4 Unless otherwise specified, fittings and piping exposed to view are to be chrome plated and polished.
- .5 Fittings located in areas other than private washrooms are to be vandal-proof.
- .6 Fixture carriers are to be suitable in all respects for the fixture they support and construction in which they are located.
- .7 Floor flanges for floor mounted water closets are to be cast iron or brass, secured to floor to prevent movement and complete with a wax seal and brass or stainless steel bolts, nuts, and washers. Plastic floor flanges will not be acceptable.
- .8 Proper seal to mate with fixture carrier flange and produce a water-tight installation.
- .9 Exposed traps for fixtures not equipped with integral traps, such as lavatories, are to be adjustable chrome plated cast brass "P" traps with cleanouts, minimum #17 gauge chrome plated tubular extensions, and chrome plated escutcheons, all to suit fixture type and drain connection.
- .10 Concealed traps for fixtures not equipped with integral traps, such as counter sinks, are to be adjustable cast brass with cleanout plugs, all to suit fixture type and drain connection.
- .11 Exposed supplies for fixtures which do not have supply trim/fittings with integral stops, i.e. lavatories, are to be solid chrome plated brass angle vales with screwdriver stops for public areas, wheel handle stops for private areas, flexible stainless steel risers, and stainless steel or chrome plated steel escutcheons, all arranged and sized to suit fixture.
- .12 Water piping as specified, complete with ball type shut-off valves as specified with water piping, or Dahl Bros. Canada Ltd. ¼ turn Mini Ball Valves.
- .13 All above grade drainage piping associated with waterclosets and showers are to be Class 4000 cast iron.

2.02 PLUMBING FIXTURES AND FITTINGS

.1 Plumbing fixtures and fittings are to be in accordance with the following:

.1 WC-1 TOILET - WALL MOUNTED WITH WALL OUTLET

- .1 American Standard 2257101.020 Toilet – Aftwall Millenium Flowise Toilet, Wall Hung with Wall outlet. Toilet Operates in the range of 4.2 to 6.0 lpf (1.1 – 1.6 gpf), white finish vitreous china, elongated bowl.
- .2 Centoco 1500STSCSSFE-001 Seat - FAST-N-LOCK, For elongated bowl, Open front, Heavy-duty, For commercial applications, Polypropylene, Toilet seat, Less seat cover, Self-sustaining plastic commercial check hinges, and Stainless steel hinge pin, Specified in White finish, FAST-N-LOCK mounting system with stainless steel bolts, 32 mm (1-1/4") high, 473 mm (18-5/8") long, 368 mm (14-1/2") wide.
- .3 Sloan SL-ECOS 8111-1.28 OR Flush Valve - ECOS® Automatic no-touch Exposed Water closet flushometer, High Efficiency 4.8 LPF (1.28 GPF), 38 mm (1-1/2") spud coupling For top spud toilet, Battery powered, constructed from Semi-red brass, Polished chrome finish, Chloramine resistant PERMEX® synthetic rubber diaphragm, Smart Sense Technology™ self-adaptive infrared sensor, Sensor located on engineered metal cover with replaceable lens window, Courtesy Flush® electrical override button, Flush tube for 292 mm (11-1/2") rough-in, 25 mm (1") I.P.S. screwdriver Bak-Chek® angle control stop with free spinning vandal-resistant stop cap, Dual-filtered bypass, Sweat solder adapter kit with cover tube, High back pressure vacuum breaker, 25 mm (1") supply pipe, Cast wall flange with set screw, No external volume adjustment, Four (4) AA-size alkaline batteries included.
- .4 Watts ISCA-101-L/R-M11 Carrier - Closet Carrier, Industry Standard single Horizontal adjustable Closet Carrier, Adjustable for standard and wheelchair height, 102 mm (4") no hub waste, 51 mm (2") no hub vent connections, patented compression seal faceplate assembly, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron foot support, neoprene bowl gasket, epoxy coated cast iron, integral test cap, chrome cap nuts, Plated hardware, Adjustable ABS nipple, Tiling frame, Compliances and certifications: Carrier complies with requirements of ASME A112.6.1M up to a 500 lb (227 kg) static load.
- .5 Mission NO HUB Series Coupling - shielded No-hub (MJ) coupling, For non-pressure gravity flow applications only, Recommended for above ground installations, (2 or 4) Type 301 stainless steel worm drive clamps, Type 301 corrugated stainless steel shield, One-piece molded elastomeric sealing gasket, Tightened to 69 kg.cm (60 in-lb) max. torque, Stainless steel conforms to ASTM A240/A240M, Meets & exceeds performance standard ASTM C1277, Rubber conforms to ASTM C564, Meets or exceeds all CISPI® 310 specifications, Conforms to CSA CLASS 7021 (B602), IAPMO FILE 0743 listed.

.2 WC-2 TOILET - WALL MOUNTED WITH WALL OUTLET – BARRIER FREE

- .1 American Standard 2257101.020 Toilet – Aftwall Millenium Flowise Toilet, Wall Hung with Wall outlet. Toilet Operates in the range of 4.2 to 6.0 lpf (1.1 – 1.6 gpf), while finish vitreous china, elongated bowl.
- .2 Centoco 1500STSCSSFE-001 Seat - FAST-N-LOCK, For elongated bowl, Open front, Heavy-duty, For commercial applications, Polypropylene, Toilet seat, Less seat cover, Self-sustaining plastic commercial check hinges, and Stainless steel hinge pin, Specified in White finish, FAST-N-LOCK mounting system with stainless steel bolts, 32 mm (1-1/4") high, 473 mm (18-5/8") long, 368 mm (14-1/2") wide.
- .3 Sloan SL-ECOS 8111-1.28 OR Flush Valve - ECOS® Automatic no-touch Exposed Water closet flushometer, High Efficiency 4.8 LPF (1.28 GPF), 38 mm (1-1/2") spud coupling For top spud toilet, Battery powered, constructed from Semi-red brass, Polished chrome finish, Chloramine resistant PERMEX® synthetic rubber diaphragm, Smart Sense Technology™ self-adaptive infrared sensor, Sensor located on engineered metal cover with replaceable lens window, Courtesy Flush® electrical override button, Flush tube for 292 mm (11-1/2") rough-in, 25 mm (1") I.P.S. screwdriver Bak-Chek® angle control stop with free spinning vandal-resistant stop cap, Dual-filtered bypass, Sweat solder adapter kit with cover tube, High back pressure vacuum breaker, 25 mm (1") supply pipe, Cast wall flange with set screw, No external volume adjustment, Four (4) AA-size alkaline batteries included.
- .4 Watts ISCA-101-L/R-M11 Carrier - Closet Carrier, Industry Standard single Horizontal adjustable Closet Carrier, Adjustable for standard and wheelchair height, 102 mm (4") no hub waste, 51 mm (2") no hub vent connections, patented compression seal faceplate assembly, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron foot support, neoprene bowl gasket, epoxy coated cast iron, integral test cap, chrome cap nuts, Plated hardware, Adjustable ABS nipple, Tiling frame, Compliances and certifications: Carrier complies with requirements of ASME A112.6.1M up to a 500 lb (227 kg) static load.
- .5 Franke Commercial CM-16104-WM Backrest – Wall mounting, Back Rest, Solid Core Plastic Laminate Panel Back, Antique White.
- .6 Mission NO HUB Series Coupling - shielded No-hub (MJ) coupling, For non-pressure gravity flow applications only, Recommended for above ground installations, (2 or 4) Type 301 stainless steel worm drive clamps, Type 301 corrugated stainless steel shield, One-piece molded elastomeric sealing gasket, Tightened to 69 kg.cm (60 in-lb) max. torque, Stainless steel conforms to ASTM A240/A240M, Meets & exceeds performance standard ASTM C1277, Rubber conforms to ASTM C564, Meets or exceeds all CISPI® 310 specifications, Conforms to CSA CLASS 7021 (B602), IAPMO FILE 0743 listed.

.3 L-1 – WALL HUNG LAVATORY

- .1 American Standard 0321.075 Basin - DECLYN®, Wall-hung Lavatory, Vitreous china, 3-hole 100mm (4") centerset, White finish, Rear overflow. Overall Dimensions: 470 mm (18-1/2") long, 432 mm (17") wide, 165 mm (6-1/2") high, Bowl Dimensions: 273 mm (10*3/4") long, 362 mm (14-1/4") wide, 152 mm (6") deep.
- .2 Moen 8894 Faucet - Manual, Single handle, Lavatory faucet, Polished chrome finish, Moen Model 99551 Anti-Rotation Deck Plate, Lead Free ANSI/NSF 61 compliant, brass construction, Auto timed metering cartridge, 1.9 LPM (0.5 GPM) maximum flowrate, Vandal-resistant pressure compensating non-aerated spray outlet, 0.2 GPC (0.75 LPC) maximum per cycle, Integral cast brass spout, 102 mm (4") spout reach, 143 mm (5-5/8") high, Push button. ADA compliant.
- .3 McGuire 155A Fixture Drain - Straight drain, Cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17 gauge 32 mm (1-1/4") Ø tailpiece, 17 gauge 152 mm (6") long, Brass locknut, Heavy rubber basin washer Fiber friction washer, ASME A112.18.2 CSA B125.2, CSA compliant
- .4 McGuire 8872C P-Trap - Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Steel shallow flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant
- .5 Watts WCA-411 Carrier - WCA-411/WCA-411-WC, Lavatory carrier, Single floor-mounted lavatory carrier with concealed arms, For concealed arm carrier, adjustable arms, epoxy coated cast iron, integral welded feet, upper tie rod, Heavy gauge steel offset uprights, basin locking device, Plated hardware, levelling screws.

.4 L-2 – WALL HUNG LAVATORY – BARRIER FREE

- .1 American Standard 9134004EC Basin - DECORUM®, Wall-hung Lavatory, Vitreous china, 3-hole 100mm (4") centerset, EverClean® antimicrobial surface, White finish, Single hole centerset, Rear overflow. Overall Dimensions: 533 mm (21") long, 514 mm (20-1/4") wide, 181 mm (7-1/8") high, Bowl Dimensions: 381 mm (15") long, 370 mm (14-9/16") wide, 127 mm (5") deep.
- .2 American Standard 0062000 Shroud- Acrylic shroud/knee contact guard less EverClean.
- .3 Moen 8894 Faucet - Manual, Single handle, Lavatory faucet, Polished chrome finish, Moen Model 99551 Anti-Rotation Deck Plate, Lead Free ANSI/NSF 61 compliant, brass construction, Auto timed metering cartridge, 1.9 LPM (0.5 GPM) maximum flowrate, Vandal-resistant pressure compensating non-aerated spray outlet, 0.2 GPC (0.75 LPC) maximum per cycle, Integral cast brass spout, 102 mm (4") spout reach, 143 mm (5-5/8") high, Push button. ADA compliant.
- .4 McGuire 155WC Fixture Drain - Offset drain, Cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17 gauge 32 mm (1-1/4") Ø tailpiece, 17 gauge, Brass locknut, Heavy rubber basin washer Fiber friction washer, ASME A112.18.2 CSA B125.2, CSA compliant

- .5 McGuire 8872C P-Trap - Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Steel shallow flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant
 - .6 Watts WCA-411 Carrier - WCA-411/WCA-411-WC, Lavatory carrier, Single floor-mounted lavatory carrier with concealed arms, For concealed arm carrier, adjustable arms, epoxy coated cast iron, integral welded feet, upper tie rod, Heavy gauge steel offset uprights, basin locking device, Plated hardware, levelling screws.
- .5 L-3 – WALL HUNG LAVATORY – BARRIER FREE
- .1 American Standard 9134004EC Basin - DECORUM®, Wall-hung Lavatory, Vitreous china, 3-hole 100mm (4") centerset, EverClean® antimicrobial surface, White finish, Single hole centerset, Rear overflow. Overall Dimensions: 533 mm (21") long, 514 mm (20-1/4") wide, 181 mm (7-1/8") high, Bowl Dimensions: 381 mm (15") long, 370 mm (14-9/16") wide, 127 mm (5") deep.
 - .2 American Standard 0062000 Shroud- Acrylic shroud/knee contact guard less EverClean.
 - .3 Moen 8894 Faucet - Manual, Single handle, Lavatory faucet, Polished chrome finish, Moen Model 99551 Anti-Rotation Deck Plate, Lead Free ANSI/NSF 61 compliant, brass construction, Auto timed metering cartridge, 1.9 LPM (0.5 GPM) maximum flowrate, Vandal-resistant pressure compensating non-aerated spray outlet, 0.2 GPC (0.75 LPC) maximum per cycle, Integral cast brass spout, 102 mm (4") spout reach, 143 mm (5-5/8") high, Push button. ADA compliant.
 - .4 Lawler 570-86820 Mixing Valve – Point of Use, thermostatic master water mixing control valve, lead free brass body construction, nickel plated finish, 1.9-30 lpm (0.5-8 gpm) range for flow rate, 11lpm (3 gpm) tempered flowrate @ 5psi pressure drop, 4-7/8" (124mm) height, 3/8" MNPT (9.5mm) inlet, 95-115F outlet water temperature range, 3/8" MNPT (9.5mm) outlet, internal checks, 125PSI max hydrostatic pressure, +/- 20% pressure variation.
 - .5 McGuire 155WC Fixture Drain - Offset drain, Cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17 gauge 32 mm (1-1/4") Ø tailpiece, 17 gauge, Brass locknut, Heavy rubber basin washer Fiber friction washer, ASME A112.18.2 CSA B125.2, CSA compliant
 - .6 McGuire LFBV170 Supply - CONVERTIBLE™ Commercial Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Brass body, Chrome-plated finish, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Convertible loose key/triangle handle, Quarter turn ball valve, Angle stop, C.P. wrought steel deep bell wall flange (standard), C.P. prefabricated 127 mm (5") copper sweat tube extension nipple, 305 mm (12") C.P. lavatory flexible copper riser tubes (standard), 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D. outlet, 82 °C (180 °F) maximum during high-temperature system flush, AB 100 compliant, ASME A112.18.1 compliant, ASME A112.18.2-2 (risers), CSA B125.2 compliant (risers), Certified to NSF/ANSI 372, Certified to NSF/ANSI 61, UPC compliant.

- .7 McGuire 8872C P-Trap - Heavy cast brass, Adjustable P-Trap, 292 mm (11-1/2") distance, With cleanout plug, Steel shallow flange, Neoprene gasket, Slipnuts, 17 gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant
 - .8 Watts WCA-411 Carrier - WCA-411/WCA-411-WC, Lavatory carrier, Single floor-mounted lavatory carrier with concealed arms, For concealed arm carrier, adjustable arms, epoxy coated cast iron, integral welded feet, upper tie rod, Heavy gauge steel offset uprights, basin locking device, Plated hardware, levelling screws.
- .6 MS-1 FLOOR MOUNTED MOP SERVICE SINK
- .1 Stern Williams SB-902-T-35-T-40-BP Sink - Single compartment sink, Mop service sinks, Without faucet ledge, Precast terrazzo Pearl grey marble chips and white Portland cement, 76 mm (3") pipe size, cast integrally and provides for a caulked lead connection not less than 25 mm (1") deep to a 76 mm (3") pipe, flat stainless steel strainer, Two side tiling flanges, with stainless steel cap. Bowl Dimension: 546 mm (21-1/2") long, 546 mm (21-1/2") wide, 254 mm (10") deep, Overall Dimension: 610 mm (24") long, 610 mm (24") wide, 305 mm (12") high.
 - .2 Stern Williams T-35 Hose and wall hook. Hose 36" long, with 3/4" chrome couplings. Wall bracket of stainless steel.
 - .3 Stern Williams T-40 Stainless Steel Mop Hanger of stainless steel with #4 finish. 24" long, with 3 rubber spring loaded grips.
 - .4 Stern Williams BP Splash Catcher Panels of 20 ga. type 304 stainless steel.
 - .5 Chicago Faucets 897-RCF Faucet - Wall-hung, Manual, Two handles, Mop sink faucet, Rough chrome plated finish, 194 - 213 mm (7-5/8" to 8-3/8") adjustable centerset, Round wall escutcheons, Brass construction, Less supply, Adjustable supply arms, 1/4 turn ceramic cartridge, No flow restrictor, Threaded hose end, Spout with pail hook, 146 mm (5-3/4") spout reach, 273 mm (10-3/4") high, Top brace, 60 mm (2-3/8") lever handle with indexed buttons, Less drain, Atmospheric vacuum breaker is not intended for continuous pressure applications.
- .7 EW-1 EYEWASH, WALL MOUNTED
- .1 Guardian G1750-G3600LF-T Emergency Equipment - Wall mounted, constructed from Stainless steel, Thermostatic mixing valve blends hot and cold water, 283 mm (11-1/8") Ø bowl size, Corrosion resistant powder coated finish finish, Two FS-Plus spray heads with flip top dust cover each, 13 mm (1/2") Ø I.P.S. chrome-plated brass stay open ball valve, 13 mm (1/2") Ø NPT female inlet supply inlet, Chrome-plated brass tailpiece and trap with 38 mm (1-1/2") I.P.S. connection, 32 mm (1-1/4") Ø NPT female outlet, Codes and Compliances:, ANSI compliant.

- .2 Lawler 911E/F-Unit 84908 Mixing Valve - Emergency mixing valve, Thermostatic High-low master water mixing valve, 229 x 205 x 127 mm (9" x 8" x 5") , Rough bronze finish, Temperature adjustment shall be vandal-resistant, 7.5 LPM (2 GPM) tempered flowrate @ 5 PSI pressure drop, 11 LPM (3 GPM) tempered flowrate @10 PSI pressure drop, 18 LPM (5 GPM) tempered flowrate @ 20 PSI pressure drop, 26 LPM (7 GPM) tempered flowrate @ 20 PSI pressure drop, In the event that the liquid motor fails, the control mechanism closes off the hot water port with the reverse seat and fully opens the internal variable bypass to allow cold water flow, The control mechanism shall employ a liquid-filled thermostatic motor to drive the valve without additional power requirements. The control mechanism shall employ a stainless steel sliding piston control device with reverse seat closure and both fixed and variable cold water bypass, Listed to ASSE 1071, 32 mm (1-1/4") NPT inlet, 32 mm (1-1/4") NPT outlet, In the event of interruption of the hot water supply, the control mechanism shall allow cold flow through both the fixed and variable bypass., Outlet Thermometer, In the event of interruption of the cold water supply, the control mechanism closes off the hot water port, stopping all flow. Positive hot water shut-off, 85 F, 125 PSI max inlet pressure, 70-90 F, 120 F Recommended inlet temperature, 65 PSI recommended operating pressure, 38 LPM (10 GPM) tempered flowrate @ 40 PSI pressure drop.

2.03 ACCEPTABLE MANUFACTURERS

- .1 Subject to compliance with requirements, manufacturers that may be incorporated into the Work include, but are not limited to, following:
 - .1 Flush Valves:
 - .1 Sloan
 - .2 Delta Commercial;
 - .2 Plumbing Brass:
 - .1 Moen Commercial.
 - .3 Stainless Steel Sinks:
 - .1 Franke Commercial;
 - .2 Novanni Commercial;
 - .3 Elkay;
 - .4 Arch Metal Ind.
 - .4 Drain Fittings, Angle Supplies, and Traps:
 - .1 McGuire;
 - .2 Delta Commercial;
 - .3 Zurn Industries.
 - .5 Fixture Carriers:

- .1 Watts Industries;
- .2 Jay R. Smith;
- .3 Zurn Industries.
- .6 Water Closets, Lavatories, and Urinal:
 - .1 American Standard;
- .7 Thermostatic Mixing Valves:
 - .1 Lawler;
- .8 Shower and Associated Trim:
 - .1 Acorn;
 - .2 Bradley.
- .9 Toilet Seats:
 - .1 Centoco;
- .10 Electronic "No Touch" Flush Valves:
 - .1 Sloan;
 - .2 Delta Commerical;
- .11 Washfountains; Multilavs:
 - .1 Acorn

2.04 CAULKING

- .1 General Electric Series SCS-1200 Silicone Construction Sealant or Dow Corning 780 silicone rubber sealant with primers as recommended by sealant manufacturer. Caulking colour(s) for coloured fixtures other than white, if any, will be selected by Consultant from sealant manufacturer's standard colour range.

3 EXECUTION

3.01 DEMOLITION

- .1 Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.02 INSTALLATION OF PLUMBING FIXTURES AND FITTINGS

- .1 Provide required plumbing fixtures and fittings.
- .2 Where new fixtures and fittings are to be connected to existing piping, include for required piping revisions

- .3 Connect plumbing fixtures and fittings with minimum piping sized in accordance with below. Refer to manufacturer's published connection (rough-in) requirements. Where manufacturer requires piping connection larger than shown below, provide piping accordingly:

FIXTURE AND/OR FITTING	DRAIN SIZE MM (IN.)	VENT SIZE MM (IN.)	DHW SIZE MM (IN.)	DCW SIZE MM (IN.)	TEMP WATER SIZE MM (IN.)
Water Closets Flush Valve Type	100 (4)	38 (1-½)	-----	25 (1)	-----
Lavatories	32 (1-¼)	32 (1-¼)	12 (½)	12 (½)	-----
Prefab. Mop Sinks with Drain	75 (3)	38 (1-½)	20 (¾)	20 (¾)	-----
Emergency Eye Wash	32 (1-¼)	32 (1-¼)	12 (½)	12 (½)	-----

- .4 Confirm exact location of plumbing fixtures and trim prior to roughing-in. Refer to architectural plan and elevation drawings.
- .5 When installation is complete, check, and test operation of each fixture and fitting. Adjust or repair as required.
- .6 For barrier-free fixtures, comply with mounting height and other requirements of governing Code(s).
- .7 Supply templates for counter mounted fixtures and trim and hand to trades who will cut the counter. Ensure openings in counter are properly located.
- .8 For electronic flush valves, locate transformer in ceiling space above electronic units to be served. Coordinate locations with electrical trade who will provide 120 volt line supply to transformers. Provide low voltage wiring from transformers to each electronic flush valve terminal point. Electrical line supply and low voltage wiring is to be concealed and access to transformer must be provided for servicing.
- .9 Confirm exact mixing valve and shower head locations prior to roughing-in.

3.03 CAULKING AT PLUMBING FIXTURES AND FITTINGS

- .1 Caulk around plumbing fixtures and fittings where they contact walls, floors, and any other building surface.
- .2 Clean areas/surfaces to be caulked and prime in accordance with sealant manufacturer's instructions. Where damage to a building surface may occur, mask surface to prevent damage and ensure a clean exact edge to the caulking bead.
- .3 Apply caulking using a gun with proper size and shape of nozzle and force sealant into joints to ensure good surface contact and a smooth and even finished bead of sealant.
- .4 If joints have been masked sealant may be tooled in a continuous stroke to obtain complete void filling. Remove masking tape immediately after tooling and before sealant begins to skin.

3.04 DISHWASHER CONNECTIONS

- .1 Provide roughed-in water and drain connections for where Owner supplied dishwasher consisting of:
 - .1 15 mm (½") dia. domestic hot water connection with a Dahl "Mini-Ball" valve with hose end and water hammer arrestor;
 - .2 40 mm (1-½") dia. DWV copper drain connection with "P" trap and cleanout plug.

3.05 CLOTHES WASHER CONNECTIONS

- .1 Provide roughed-in water and drain connections for where Owner supplied clothes washer consisting of:
 - .1 15 mm (½") dia. piping connection for both hot and cold water, each terminated in a Dahl "Mini-Ball" Valve with hose end and water hammer arrestor;
 - .2 50 mm (2") dia. standing waste with a height to suit the washer drain and complete with a "P" trap.

END OF SECTION

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies piping, valves, and piping accessories and specialties for following vehicle service piping systems:
 - .1 compressed air.

1.02 DEFINITIONS

- .1 "rusty" – when used to describe piping means piping that is covered by rust over more than 5% of its surface area, either inside or outside the pipe, or both.

1.03 TSSA DESIGN REGISTRATION

- .1 Registration of piping system designs with the Technical Standards and Safety Authority (Boilers and Pressure Vessels Division) will be completed by Owner.

1.04 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe and fittings. Include engineering design data to confirm products proposed meet requirements specified in this Section. Include certified power and control wiring diagrams where applicable.
- .2 Submit copies of all test and inspection reports, including test reports supplied by authority making the inspection, for all inspections specified in this Section. Complete and submit TSSA "Piping Systems Installation and Test Data Report", and submit all other documents required by TSSA.
- .3 Submit valid and up-to-date qualification certificates for tradesmen performing the work, all as specified in this Section.
- .4 Submit identified samples as follows:
 - .1 sample of each fitting, union and flange to be used;
 - .2 sample of each type of valve to be used.
- .5 Submit closeout documents in accordance with requirement specified in Division 01, and include following:
 - .1 copies of all specified test and inspection reports;
 - .2 maximum allowable operating pressure of each system, actual working pressure of each system, and pressure rating of all system components;
 - .3 setting of each pressure regulator, PRV, etc.;
 - .4 copy of piping system registration documents which will be supplied by Owner.

1.05 QUALITY ASSURANCE

- .1 Prior to submitting shop drawings/product data sheets for any system governed by the Boilers and Pressure Vessels Act, review Contract Documents for conformance with CSA B51 and related standards, and immediately report any discrepancies so as not to delay the work. This review is intended to avoid installation of materials and/or products that may later be rejected by TSSA.
- .2 Employ a subcontractor approved by TSSA (Boiler and Pressure Vessels Division), who has a Quality Plan filed with TSSA to complete the work of this Section, and who has successfully completed similar pressure piping system work within past 5 years.
- .3 Work is to be performed only by certified welders in accordance with requirements of Section entitled Basic Mechanical Materials and Methods, and by certified journeyman pipe fitters and licensed petroleum mechanics. Maintain copies of each registered tradesman's certificate on-site for examination upon request.
- .4 Install all work required to be registered under Boiler and Pressure Vessels Act in accordance with requirements of this Section and CSA B51, including related Codes and Standards.
- .5 Schedule, pay costs, and obtain reports for inspections by governing authority at regular intervals including but not limited to pre-construction material inspection, demonstration of welding procedures, general installation inspections, and any other inspection(s) requested by governing authority.
- .6 Provide fire safe valves in all piping conveying flammable and combustible liquids in accordance with governing Fire Codes.

2 PRODUCTS

2.01 PIPE

- .1 Mild black carbon steel pipe, ASTM A53 or A106, Grade B, ERW, Schedule 40, Schedule 80, Schedule 160, or XXS as specified in Part 3.

2.02 FITTINGS

- .1 Wrought steel butt weld fittings to ASME/ANSI B16.9, with a wall thickness to match associated pipe.
- .2 Malleable iron screwed fittings to ASME/ANSI B16.3, of a Class to suit maximum pipe working pressure at listed pipe size and operating temperature as follows:
 - .1 Class 150
 - .1 for pipe NPS 75 mm (3") and smaller with maximum 2070 kPa (300 psi) working pressure and an operating temperature less than 65°C (150°F).

2.03 PIPING UNIONS

- .1 Malleable iron screwed unions and flanges to ASTM A197 and ANSI/AWS B2.1, to suit piping material and system pressure.

2.04 WELDED JOINTS

- .1 In accordance with requirements of Section entitled Basic Mechanical Materials and Methods, and requirements specified in this Section.

2.05 SCREWED JOINTS

- .1 In accordance with requirements of Section entitled Basic Mechanical Materials and Methods and requirements of this Section, with pipe threads to ANSI/ASME B31.1 and B1.20.

2.06 BALL TYPE SHUT-OFF VALVES

- .1 Unless otherwise specified, full port carbon steel valves to MSS SP-110, inspected and tested in accordance with API 598, each with pressure-temperature ratings to ASME/ANSI B16.34, dimensions in accordance with ASME/ANSI B16 Standards, pressure tested to MSS SP-61, and complete with a stainless steel ball and stem, a "PTFE" seat, a removable identified stainless steel lever handle and nut, and a CRN.
- .2 Unless otherwise specified, valves are to be product of a single manufacturer.
- .3 Shut-off valves, unless otherwise specified, are to be as follows:
 - .1 threaded ends – 20,685 kPa (3000 psi) WOG rated, Conbraco Industries "Apollo" #72-100 or M.A. Stewart #CSSF3HD-FS;
 - .2 socket weld ends – three-piece body design, 8620 kPa (1250 psi) WOG rated, Conbraco Industries "Apollo" #83-400 or M. A. Stewart # CSSF3HDFS-SW;
 - .3 socket weld double union ends – Conbraco Industries "Apollo" #73-400, 20,685 kPa (3000 psi) WOG rated, with type 316 stainless steel ball and stem, and RPTFE seat, bearing and packing.

2.07 STRAINERS

- .1 Screwed
 - .1 Toyo Fig. 380, bronze, 2080 kPa (300 psi) WOG rated "Y" pattern with a stainless steel strainer screen with, unless otherwise specified, perforations sized to the recommendations of manufacturer of equipment the strainer is protecting.
- .2 Flanged
 - .1 Toyo Fig. 381A, cast iron, 1380 kPa (200 psi) WOG rated, "Y" pattern with bolted cover, drain port, and a stainless steel strainer screen as specified for screwed strainers.
- .3 Screens for strainers ahead of flow meters are to have 60 mesh.
- .4

3 EXECUTION

3.01 DEMOLITION

- .1 Perform required vehicle service piping demolition work. Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.02 PIPING SYSTEM MATERIALS

- .1 Unless otherwise specified, piping system materials are to be as follows:
 - .1 compressed air piping
 - .1 carbon steel, Schedule 40, screwed with Class 150 malleable iron fittings and threaded joints for piping 65 mm (2-½") dia. and smaller, welded with butt weld fittings and welded joints for piping larger than 65 mm (2-½") dia.;

3.03 PREPARATION

- .1 Layout work generally in accordance with lines and grades indicated, however, verify lines, levels and dimensions indicated against established benchmarks. Report any discrepancies and obtain a written instruction to proceed.
- .2 Adjust piping routes and/or equipment locations to avoid conflicts with new or existing work and elements of building.
- .3 Maintain sufficient clearances for routine maintenance of equipment, and where piping/equipment is installed and conflicts with maintenance access to equipment or other services, relocate piping/equipment to suit at no extra cost to Contract.

3.04 INSPECTIONS AND TESTS

- .1 Leave piping system joints uncovered until all tests are completed and systems have been inspected and approved.
- .2 When piping systems are complete and ready for pressure testing, notify Consultant and governing authorities so piping can be inspected for compliance with Contract Documents.
- .3 Pay costs for inspections and tests required by and witnesses by governing authorities, and supply a scissor lift and trained operator as required for inspections and tests, and safety harnesses for all personnel involved with inspections and tests.
- .4 Work governed by Boiler and Pressure Vessels Act and in jurisdiction of TSSA, and indicated on or in Contract Documents registered with TSSA is to be subject to TSSA inspections and tests. Coordinate installation and testing activities and inspection requirements with TSSA, and as a minimum:
 - .1 schedule regular TSSA inspection of all system components prior to installation, and supply any documentation required by TSSA to confirm piping system components conform to Contract requirements;
 - .2 schedule regular TSSA inspection of welds and joints as they are made, and, at no additional cost to Contract, perform radiographic or ultrasonic testing of all welds which fail TSSA visual inspection;
 - .3 supply credentials of all tradesmen to TSSA;
 - .4 conduct any tests required by TSSA to prove welders qualifications;
 - .5 notify TSSA in advance of pressure tests so tests may be witnessed by TSSA, and retest any system when requested by TSSA, to the satisfaction of TSSA, at no additional cost to Contract;

- .6 correct any deficiencies noted by TSSA to the satisfaction of TSSA and at no additional cost to Contract;
- .7 do not put any system governed by Boiler and Pressure Vessels Act into service until TSSA and Consultant has reviewed the system.
- .5 Refer to welding requirements specified in Section entitled Basic Mechanical Materials and Methods. Perform inspections of welds in medium and high pressure steel piping as follows:
 - .1 inspections are to be performed by a specialist inspection/testing company;
 - .2 perform radiographic inspection on a selected 10% of welds in medium and high pressure piping;
 - .3 if inspection of any joint fails, perform radiographic testing on all joints done by the welder whose joint failed, and radiograph all repaired joints until satisfactory results are obtained;
 - .4 radiograph inspections in accordance with ANSI/ASME B31.1;
 - .5 perform magnetic particle tests on welded slip-on flanges;
 - .6 submit results of all inspections/tests accompanied by copies of welder's licence(s) and description of procedures used to TSSA Inspector and to Consultant.

3.05 GENERAL PIPING SYSTEM INSTALLATION REQUIREMENTS

- .1 Install systems governed by Boilers and Pressure Vessels Act in accordance with CSA B51 and all related Codes and Standards (including ANSI/ASME B31.1) governing selection of piping, fittings, joining methods, welding, valves, etc.
- .2 Clean piping inside and outside prior to installation. Remove rust and scale. De-bur pipe after cutting and chips after threading. Cap open ends of piping during installation.
- .3 Unless otherwise shown or specified, provide screwed joints only at last valve before connection to equipment. Provide machine cut threads and approved joint compound on male threads only.
- .4 Unless otherwise shown or specified, joints are to be welded, except where flanged joints are required. Use graphite lubricant on flange bolts and nuts, and tighten nuts with a torque wrench.
- .5 Use welding tees, socket or butt weld type only. Where reducing tees of the proper size are unavailable, use available tees with reducers. Tees with increasers, "Weldolets", "Thredolets", half-couplings, and pipe-to-pipe welded branch connections are not acceptable.
- .6 Conform to following:
 - .1 maintain clearance around piping and equipment and between piping, equipment and structure for proper operation, maintenance and/or removal of piping and equipment without interrupting operation of other systems, and, where required, to permit proper application of thermal insulation;

- .2 coordinate location of piping and piping system components with ductwork, other piping systems, lighting, sprinkler heads, and similar items and provide necessary clearances for maintenance;
 - .3 where installation/routing interference problems arise, prepare and submit a dimensioned drawing to indicate proposed solution to interference problem, and do not proceed until Consultant's review has been completed.
- .7 Provide pipe hangers and supports in accordance with requirements in Section entitled Basic Mechanical Materials and Methods and any drawing details. Conform to following requirements:
- .1 neatly arrange piping on common trapeze type hangers with equal spacing between each pipe and sufficient space for any other pipe system material indicated on drawings, and route to avoid interference as specified above;
 - .2 brace piping securely to building structure by means of additional structural steel as required where pipe movement occurs due to valve or equipment operation;
 - .3 submit bracing and additional support details for review prior to installation.
- .8 Provide required shut-off valves, including valves at each piece of equipment, to isolate branch piping, as required to permit installation and testing of piping, and as required to permit flushing, cleaning and charging of piping, whether shown on drawings or not. Installation requirements as follows:
- .1 provide fire safe steel valves in piping conveying flammable/combustible liquids;
 - .2 install valves in horizontal piping with stem and handle in upright position above horizontal in vertical alignment, and install valves in vertical piping with stem and handle away from wall or other obstructions;
 - .3 arrange and locate valves so handle indicates normal direction of flow with valve open, and so handles, in all possible positions, do not interfere with adjacent piping, other valves, structure, etc.;
 - .4 valves in mains and to isolate branch lines are to be socket weld or flanged;
 - .5 valves at hose connections are to be threaded unless otherwise indicated;
 - .6 for 3-piece valves and SAE flanged valves remove middle section during socket welding and provide an adequate spacer to maintain spacing and alignment;
 - .7 tag valves and submit a valve chart with floor plan in accordance with requirements of Section entitled Basic Mechanical Materials and Methods;
 - .8 maintain records of valve CRN's and submit a list to governing authority;
 - .9 support valve inlet and outlet piping within 300 mm (12") of valve;
 - .10 wherever possible, locate valves so as to be visible from floor and not obstructed by ductwork or suspended ceilings, and where this is not possible, provide signage indicating location of visually obstructed valve;

- .11 except for valves at equipment, locate valves within hand reach from floor level wherever possible, or if not possible, within hand reach from a 3 m (10') step ladder, or, if not possible, within hand reach from a scissor lift.
- .9 Provide drain valves at piping low points, at equipment connections, at piping section isolating valves, and wherever else required to permit complete drainage of piping systems, whether shown on drawings or not.
- .10 Provide strainers in pump suction piping and in inlet piping to flow meters, generally where shown but with exact location to permit easy access for removal of strainer screen.
- .11 Provide flow meters in pump suction piping for piping services. Install in accordance with manufacturer's instructions.

3.06 PRESSURE TESTING

- .1 When piping systems are complete and have successfully passed all inspections/tests previously specified, and before concealing piping from view (including insulation), perform hydrostatic pressure tests in presence of Consultant and, if required, governing authority's inspector. Give a minimum of 5 working days' notice of intention to do testing. Testing of systems may be done in Sections as confirmed with Consultant.
- .2 Pressure testing parameters and requirements as follows:
 - .1 test pressures are to be 1.5 times maximum system working pressure maintained without loss of pressure for 24 hours and, unless otherwise specified, use the fluid to be conveyed by piping system as test medium;
 - .2 test pressures may be generated by means of a hydraulic hand pump (preferred), or a piston pump controlled by a regulated air supply, or an electric pump with unloader or relief set to test pressure;
 - .3 methods using on/off control of equipment to limit pressure are not permitted;
 - .4 prior to tests, isolate any equipment or piping component which may be damaged by test pressure, and indicate equipment so isolated in test reports;
 - .5 test gauges are to conform to requirements of Section entitled Basic Mechanical Materials and Methods and are to be accurately calibrated with such calibration demonstrated to Consultant upon request;
 - .6 any testing procedure deemed by Consultant or governing authority's inspector to be unsafe will be cancelled and is to be re-scheduled using an approved, safe test procedure at no extra cost to Contract;
 - .7 systems that fail pressure tests are to be drained, repaired, and retested as above at no additional cost;
 - .8 when tests have been successfully completed, submit signed test reports to Consultant and governing authority's inspector.

3.07 FLUSHING AND CLEANING

- .1 Flush and clean pressure piping after pressure testing has been successfully completed and systems are clean and operational with safety devices functional, and all isolation valves are operational and fully open. Remove devices such as flow meters and dispensing valves until flushing and cleaning is certified complete.
- .2 Flushing and cleaning solutions as follows:

Piping System	Flushing/Cleaning Solution
compressed air	water/air

- .3 Procedures for flushing and cleaning are as follows:
 - .1 for compressed air system, blow-out and flush water from hydrostatic testing as follows:
 - .1 at all drip legs and dirt pockets (at air hose stations and air regulators);
 - .2 at all hose reels;
 - .3 at all automatic drains.

3.08 START-UP OF SYSTEMS

- .1 Start-up each piping system after all cleaning, testing, and flushing has been successfully completed, and painting and identification work is complete. Arrange and pay for attendance at site of equipment manufacturer's representatives during start-up procedures, and continually supervise start-up procedures. Document start-up procedures and submit completed and signed reports.
- .2 Generally, start-up each system as follows:
 - .1 accurately set pressure controls;
 - .2 ensure air is removed from piping (except compressed air) and piping is fully charged;
 - .3 clean all strainer baskets;
 - .4 ensure proper operation and flow at each dispense, and check for leaks;
 - .5 adjust pipe hangers and supports as required, monitor movement, eliminate any pipe movement and/or vibration, and provide additional bracing as required and to the satisfaction of Consultant;
 - .6 adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, and the absence of noise or vibration transmission, and properly secure any loose items to ensure quiet system operation;
 - .7 check operation of relief valves and record settings, and test operation of operating, limit and safety controls;

- .8 adjust system operating pressures to ensure proper flow rates at dispensers, record air supply pressure and pump supply settings, and balance system flows to achieve specified flow rates at dispensers.
- .3 Refer to Section entitled Basic Mechanical Materials and Methods for additional requirements.

3.09 COMMISSIONING

- .1 Commission all systems after successful start-up and submittal of reports.
- .2 Refer to commissioning requirements specified in Section entitled Mechanical Work Commissioning.
- .3 Generally, commissioning of each system is to confirm and document operational performance of system in accordance with requirements of Contract Documents.

END OF SECTION

1 GENERAL

1.01 DEFINITIONS

- .1 "rusty" – when used to describe piping means piping that is covered by rust over more than 5% of its surface area, either inside or outside the pipe, or both.

1.02 SUBMITTALS

- .1 Submit copies of all test and inspection reports, including test reports supplied by authority making the inspection, for all inspections specified in this Section. Complete and submit TSSA "Piping Systems Installation and Test Data Report", and submit all other documents required by TSSA.
- .2 Submit valid and up-to-date qualification certificates for tradesmen performing the work, all as specified in this Section.
- .3 Submit closeout documents in accordance with requirement specified in Division 01, and include following:
 - .1 copies of all specified test and inspection reports;
 - .2 setting of each pressure regulator, PRV, etc.;
 - .3 copy of piping system registration documents which will be supplied by Owner.

1.03 QUALITY ASSURANCE

- .1 Prior to submitting shop drawings/product data sheets for any system governed by Boilers and Pressure Vessels Act, review Contract Documents for conformance with CSA B51 and related standards, and immediately report any discrepancies so as not to delay the work. This review is intended to avoid installation of materials and/or products that may later be rejected by TSSA.
- .2 Employ a subcontractor approved by TSSA (Boiler and Pressure Vessels Division), who has a Quality Plan filed with TSSA to complete the work of this Section, and who has successfully completed similar pressure piping system work within past 5 years.
- .3 Work is to be performed only by certified welders as per requirements of Section entitled Basic Mechanical Materials and Methods, and by certified journeyman pipe fitters and licensed petroleum mechanics. Maintain copies of each registered tradesman's certificate on-site for examination upon request.
- .4 Install all work required to be registered under Boiler and Pressure Vessels Act in accordance with requirements of this Section and CSA B51, including related Codes and Standards.
- .5 Schedule, pay costs, and obtain reports for inspections by governing authority at regular intervals including but not limited to pre-construction material inspection, demonstration of welding procedures, general installation inspections, and any other inspection(s) requested by governing authority.

2 PRODUCTS

- .1 Not used.

3 EXECUTION

3.01 DEMOLITION

- .1 Perform required compressed air system demolition work. Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.02 INSTALLATION OF AIR COMPRESSOR AND ACCESSORIES

- .1 Provide a new air compressor set. Secure set in place, level and plumb, on rubber-steel-rubber vibration isolation pads on a concrete housekeeping pad. Connect with required piping, including drain piping terminated over a floor drain or funnel and floor drain. Install compressor oil shipped loose.
- .2 Supply a power and control panel and wall mount. Perform required control and alarm wiring in conduit between compressor and control panel in accordance with manufacturer's wiring schematic and electrical work wiring requirements.
- .3 Wall mount refrigerated dryer and connect with piping, including condensate drain piping.
- .4 Start-up the equipment and adjust operating controls to deliver air in accordance with drawing schedule requirements.

3.03 COMPRESSED AIR PIPING INSTALLATION REQUIREMENTS

- .1 Provide required compressed air system piping, including piping to pumps, panels and equipment requiring compressed air service. Refer to Section entitled Vehicle Service Piping, Valves and Specialties, for piping materials. Provide a proper braided stainless steel flexible piping connection between receiver tank and system piping.
- .2 Extend branch piping to equipment and air hose stations off the top of the main. Refer to drawing details.
- .3 Arrange piping so condensate will drain from mains and branches into drip legs. Provide drip legs every 30 m (100') of pipe run and at end of each branch piping run, whether indicated on drawings or not.
- .4 Drip legs are to extend down from bottom of pipe and consist of a piping tee and 250 mm (10") long pipe nipple the same size as the main or branch pipe, then a reducing fitting (if required) and 12 mm (½") dia. piping extended down to floor level and terminated with a ball valve.
- .5 Provide shut-off valves at all equipment connections, in branch piping serving more than one piece of equipment, and wherever else shown.
- .6 Valves at equipment connections and wherever else shown or specified are to be lockable vent isolation valves.
- .7 Direct piping from automatic drain outlets, valve relief openings, and PRV relief openings to the floor away from work areas.
- .8 Hang compressed air piping using single hangers as per Section entitled Basic Mechanical Materials and Methods, however, where required, provide additional hangers/supports to prevent pipe system drumming and movement.

END OF SECTION

1. GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings/product data sheets for following:
 - .1 all control system components;
 - .2 identified schematic control diagrams with component identification, catalogue numbers, and sequence of operation for all systems;
 - .3 certified wiring diagrams for all systems.
- .2 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

1.2 QUALITY ASSURANCE

- .1 Control systems are to be installed by control component manufacturer or by licensed personnel authorized by control component manufacturer. Submit written confirmation from control component manufacturer.
- .2 Control system installation company is to have local parts and service availability on a 24/7 basis.
- .3 Control wiring work is to be performed by licensed journeyman electricians, or under direct daily supervision of journeyman electricians.

1.3 WARRANTY AND MAINTENANCE

- .1 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full, 8 hour day to provide additional system training as required, and to demonstrate troubleshooting procedures.

2. PRODUCTS

2.1 REFRIGERANT DETECTION SYSTEM

- .1 SELF CONTAINED CONTROLLER
 - .1 System power requirement shall be low voltage 16 - 30 VDC or 12 - 28 VAC, Class 2, or line voltage 90 - 240 VAC, 50 - 60 Hz with the addition of Option -DV.
 - .2 Communication between self contained controller and a BAS/BMS is provided by user configurable Modbus output or BACnet® output communications protocol.
 - .3 Provide real time display of gas concentration, alarm status and relay functions with an LCD display 2 x 16 characters and LED panel indicating alarm status 1, 2 and 3 for any channel and FAULT.
 - .4 Provide 2 SPDT dry contact relays rated 5A @240 VAC.
 - .5 Provide field adjustable time delays for "delays on make" and "delays on break" for each sensor to allow custom configuration of ventilation control by the system relays, if desired.
 - .6 Provide a circuit test function to allow the user to confirm system operation and exhaust fan control from the panel.
 - .7 Be connected to one remote analog sensor/transmitter capable of monitoring up to an area of 3,000 sq ft / 914 m or 31 ft / 9.44 m radius with 360-degree coverage per sensor system.
 - .8 Provide two analog output signals user configurable for current (ie. 0 - 4mA) or voltage (ie. 0 - 10v) output to be used to control fans or other equipment.

- .9 A side mounted strobe shall be included at time of order.
 - .10 Be tested to CSA/UL/CE, FCC and IP54 standards and accurate enough to meet government workplace hazardous gas exposure standards.
 - .11 The Controller shall be Critical Environment Technologies' CGAS-SC-RS-2AO-L2 or CGAS-SC-RS-2AO-DV-L2
- .2 REMOTE SENSOR FOR REFRIGERANT DETECTION
- .1 Shall have an integral infrared refrigerant sensor with a detection range of 0 - 2,000 ppm and configured alarm setpoints at 250 ppm (LOW), 500 ppm (MID), 1,000 ppm (HIGH).
 - .2 The three alarm setpoints shall be user configurable for any value in the given range. They will operate independently and have an associated relay output.
 - .3 Each chiller requires its own dedicated remote sensor to monitor for refrigerant leaks. Install the remote sensor in the area where refrigerant vapor from a leak will most likely concentrate (refrigerants are heavier than air).
 - .4 Shall operate on power supplied by the control cGas-SC Controller.
 - .5 Shall provide an analog output signal to the cGas-SC controller.
 - .6 Shall not be installed more than 300 ft / 91 m away from the cGas-SC Controller.
 - .7 Be housed in a rugged, wall mount, IP54 rated, water/dust tight ABS/polycarbonate enclosure.
 - .8 Be tested to CSA/UL/CE, FCC and IP54 standards and accurate enough to meet government workplace hazardous gas exposure standards.
 - .9 The remote gas detector shall be Critical Environment Technologies' CGAS-A-IR513A.
 - .10 Refrigerant Type: R513A.
- .3 REMOTE AUDIBLE/VISUAL STROBE/HORNS
- .1 Will be powered by a dedicated output from the cGas-SC Controller.
 - .2 Shall be connected to the cGas-SC Controller using the dedicated horn/strobe terminal or provided relay contact.
 - .3 Shall be mounted at higher elevations for visibility, inside the mechanical/chiller room and at each entrance/exit door.
 - .4 Shall activate upon HIGH alarm condition to alert in the area of gas build up at and beyond high alarm concentration.
 - .5 Shall be user selectable latching or non-latching, silenceable or non-silenceable.
- .4 ACCEPTABLE MANUFACTURERS:
- .1 Critical Environment Technologies;
 - .2 Honeywell;
 - .3 MSA Canada Inc.

3. Execution

3.1 INSTALLATION OF REFRIGERANT MONITOR

- .1 Provide a complete refrigerant concentration monitor system where shown.
- .2 Exact location of sampling points and other components shall be determined on site by the manufacturer upon review of completed refrigeration systems. Calibration of system shall be on site by manufacturer.
- .3 Confirm location of monitor panels with Consultant prior to roughing in.
- .4 Install components in strict accordance with manufacturer's instructions and wiring diagrams. Provide low voltage wiring in conduit per the requirements of electrical division.

- .5 Forward four (4) copies of letter from manufacturer certifying satisfactory installation and operation of system.
- .6 Perform required 24 volt wiring in conduit to control panel(s) and from each panel to associated sensor/transmitter units as required and in accordance with wiring requirement specified in the electrical work specification and system manufacturer's certified wiring schematics. Provide 24 volt interlock wiring to exhaust fan starters in accordance with drawing control requirements.
- .7 Integrate refrigerant detection system with Building Automation System.
- .8 Provide audible and visible alarms in easily visible locations both inside and outside the equipment room.
- .9 After installation, test to demonstrate operation of functions described above under sequence of operation by manufacturers certified technician. Issue certificate of operational and installation compliance to facility operators.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data for all products specified in Part 2 of this Section except for pipe, fittings, and unions. Indicate performance criteria, conformance to appropriate reference standards, and limitations.
- .2 For each gas pressure regulating station, submit:
 - .1 selection sheet for each PRV, indicating connected equipment, heating loads, design allowance, meter model, body size, spring range and orifice size;
 - .2 selection sheet for each relief valve(s) serving a PRV.

1.02 QUALITY ASSURANCE

- .1 Gas system work is to be in accordance with requirements of CAN/CSA B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.
- .2 Gas system work is to be performed only by licensed gas pipe fitters (holding Gas Technician 1 Certificate) authorized under TSSA Act.
- .3 Apply for, on TSSA forms, approval of gas system design by TSSA prior to work beginning at site and prior to ordering any equipment. Submit completed TSSA Form and copies of shop drawings/product data sheets as required to TSSA and obtain an approval certificate. Pay costs for TSSA review and approval process. If TSSA requires revisions to the system and revisions result in an extra cost, a Notice of Change will be issued by Consultant for the revision.

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

- .1 Uncoated Black Steel - Screwed Joints
 - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with malleable cast iron screwed fittings to ANSI B2.1, and screwed joints.
- .2 Uncoated Black Steel - Welded Joints
 - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, mill or site bevelled, complete with factory made forged steel butt welding fittings and welded joints.
- .3 Copper - Uncoated
 - .1 Type "G" seamless copper tubing to ASTM B837, hard temper with wrought copper capillary brazed joint type fittings to ASTM B.61, and brazed joints made with "Sil-Fos" or "Sil-Fos 5" brazing alloy, or, soft temper with flared brass fittings of a single 45° flare type, forged or with a machined long nut and copper to copper threaded connectors, and, where required, flared brass copper to NPS adapters.
- .4 Flexible Stainless Steel

- .1 Flexible, CSA certified, 860 kPa (125 psi) rated, gas-tight, convoluted stainless steel tubing factory jacketed with a bright yellow PVC coating which is continuously identified. Supply tubing in coils and complete with factory attached stainless steel end fittings, and adapter unions, protective plates, and steel clamps.
- .2 Acceptable products are:
 - .1 Tru-Flex Metal Hose LLC. "Pro-Flex";
 - .2 Titeflex Corp. "Gastite";
 - .3 Omega Flex Canada "TracPipe".

2.02 PIPING UNIONS

- .1 Screwed Piping
 - .1 Malleable iron, ground joint, bronze or brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).
- .2 Flanged Piping
 - .1 Forged carbon steel slip-on type raised faced welding flange unions to ASTM A105, 150 lb. Class for steel pipe, and slip-on type 150 lb. Class bronze flanges for copper pipe.
- .3 Copper to Steel
 - .1 Equal to Kamco Products "Copper Stopper".

2.03 SHUT-OFF VALVES

- .1 Ball Type
 - .1 CSA certified, minimum 3100 kPa (450 psi) WOG rated, 1/4 turn, full port non-lubricated brass ball valves, each complete with a Teflon PTFE seat, chrome plated solid ball, removable lever handle, and screwed ends.
 - .2 Acceptable products are:
 - .1 Neo Valves Inc. #425;
 - .2 Kitz Corp. Code 58;
 - .3 Toyo Valve Co. Fig. 5044A.
- .2 Plug or Ball Type
 - .1 CSA certified, plain face flanged, Class 125, 1380 kPa (200 psi) rated, 1/4 turn, cast iron lubricated plug valves, each wrench operated and complete with cylindrical plug with lubricant grooves, lubricant screw, and lubricant receptacle, or full port carbon steel ball valves with flanged ends.
 - .2 Acceptable products are:

- .1 Neo Valves Inc. #1AS40114 plug valve;
 - .2 Newman Hattersley #171M plug valve;
 - .3 Kitz Corp. Code No. 150 SCTAM-FS-CGA ball valve.
- .3 Shut off valves serving natural gas emergency generators are to be provided with valve position indicator and contact to initiate trouble alarm condition at the generator control panel.

2.04 PRESSURE REGULATORS

- .1 CSA certified pressure regulators as follows:
- .1 non-vented type: lever action, dead end lockup type, each complete with a vent limiter, self-aligning valve, die-cast aluminium housing, and synthetic rubber compound diaphragm;
 - .2 vented type: spring-loaded self-operated design, tight closing, selected for facility gas pressure and piping pressure loss, and connected equipment load at full firing rate plus 20% spare, and complete with:
 - .1 1035 kPa (150 psi) rated cast iron body finished with corrosive resistant epoxy enamel;
 - .2 aluminum diaphragm and spring case with Nitrile diaphragm, disc, and body o-ring;
 - .3 throttling type, high flow rate, tight shut-off relief valve selected to protect equipment downstream of regulator in coordination with regulator capacity.
- .2 Acceptable manufacturers are:
- .1 Maxitrol Co.;
 - .2 Fisher Controls;
 - .3 Leslie Controls Inc.;
 - .4 Lakeside Process Controls.

3 EXECUTION

3.01 NATURAL GAS SERVICE

- .1 Make required arrangement with natural gas supply utility on behalf of Owner for installation of natural gas service piping with gas pressure regulator and meter assembly.

3.02 NATURAL GAS PIPING INSTALLATION REQUIREMENTS

- .1 Provide required natural gas distribution piping and connect gas fired or operated equipment, and provide required vent piping to atmosphere, including vent piping from pressure regulators. Perform piping work in accordance with requirements of CAN/CSA B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.

- .2 Piping is to be as follows:
 - .1 for aboveground piping, uncoated Schedule 40 black steel, hard temper or soft copper, or, if permitted, flexible stainless steel.
- .3 Install flexible stainless steel pipe in strict accordance with pipe manufacturer's instructions.
- .4 Slope gas piping in direction of flow to low points.
- .5 Ensure supports for roof mounted piping are sized (height) to accommodate roof slope and required piping slope, and to permit installation of low point dirt pockets.
- .6 Provide full pipe diameter 150 mm (6") long drip pockets at bottom of vertical risers, at piping low points, and wherever else shown and/or required.
- .7 Identify natural gas piping aboveground with 2 coats of safety yellow enamel applied over primer, and SMS Ltd. or equal coil type vinyl identification makers with arrows.
- .8 For underground gas piping, provide continuous 75 mm (3") wide yellow PVC warning tape with "CAUTION - GAS LINE BURIED BELOW" wording at 750 mm (30") intervals located above pipe approximately 250 mm (10") below grade.

3.03 INSTALLATION OF SHUT-OFF VALVES

- .1 Provide CSA approved ball type or lubricated plug type shut-off valves to isolate equipment, and wherever else shown.
- .2 Ensure valves are located for easy accessibility and maintenance.

3.04 INSTALLATION OF PRESSURE REGULATORS

- .1 Provide pressure regulators in gas distribution piping where indicated and/or required.
- .2 For indoor appliances, use lever acting design vent limiter type, sized as shown and mounted in a horizontal upright position in strict accordance with manufacturer's instructions. Note: these pressure regulators do not require vent piping.
- .3 Use vented type pressure regulators for all other applications.
- .4 Install regulating stations in accordance with requirements of CAN/CSA B149.1.
- .5 Provide 6 mm (¼") diameter test ports upstream and downstream of each regulator assembly.
- .6 Locate outdoor regulating stations a minimum of 300 mm (12") away from walkways, and 3 m (10') away from equipment air intakes and building openings. Provide required vent piping and terminate vents in a turn-down elbow fitting with bronze bug screen secured in place.
- .7 Locate indoor regulating stations in locations accessible without use of ladders or lifts. Combine vents where permitted and increase vent pipe size accordingly. Extend vent piping up through roof 3 m (10') away from equipment air intakes and building openings and terminated in a turn-down elbow fitting with bronze bug screen secured in place.

- .8 Indicate operating set-points, relief settings and vent arrangements for each regulating station on as-built record drawings.

END OF SECTION

1. GENERAL

1.1 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the work of this Section is specified in other Sections of the Specification:
 - .1 supply of piping or equipment mounted temperature control components;
 - .2 domestic water piping connections to equipment;
 - .3 drainage piping connections to equipment drain pans;
 - .4 provision of boilers;
 - .5 provision of cooling tower;
 - .6 provision of heat pumps;
 - .7 provision of site applied thermal insulation for piping and equipment;
 - .8 circulating system testing, adjusting and balancing.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in this Section except piping and unions.
- .2 Submit certified performance curves with all pump shop drawings.
- .3 Submit with delivery of each unit a copy of factory inspection and test report, and include a copy of each report with O & M Manual project close-out data.
- .4 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .5 Prior to Substantial Performance of the Work, submit a spare seal flush line filter for each pump equipped with a seal flush line.
- .6 Shop drawings for piping anchors must be prepared and stamped by a professional Structural Engineer registered in the jurisdiction of the work. Refer to requirements for Contractor retained engineers specified in Section entitled Mechanical Work General Instructions.
- .7 Submit a letter from pipe anchor design engineer to stating engineer has visited site to examine installation of pipe anchors and pipe anchor installation is in accordance with reviewed anchor shop drawing.

1.3 QUALITY ASSURANCE

- .1 Pump motors are to comply with requirements of Section entitled Basic Mechanical Materials and Methods.

2. PRODUCTS

2.1 PIPE, FITTINGS AND JOINTS

- .1 Black Steel - Screwed Joint
 - .1 Mild black carbon steel, Grade B, ASTM A53, complete with Class 125 cast iron threaded fittings to ANSI/ASME B16.4, and screwed joints.
- .2 Black Steel - Welded Joint
 - .1 Mild black carbon steel, Grade B, ASTM A53, mill or site bevelled, complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, with long sweep pattern elbows unless otherwise specified, and welded joints.

2.2 PIPING UNIONS

- .1 Screwed Piping
 - .1 Malleable iron, ground joint, bronze or brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).
- .2 Flanged Piping
 - .1 Forged carbon steel slip-on type raised faced welding flange unions to ASTM A105, 150 lb. Class for steel pipe, and slip-on type 150 lb. Class bronze flanges for copper pipe.

2.3 CIRCUIT BALANCING VALVES

- .1 Tour & Andersson Series 787 threaded and Series 788 flanged for precise flow measurement, balancing, and positive shut-off with no drip seat. Each valve to be wye pattern, globe style with self-sealing EPDM measurement points, EPDM seat, and wheel handles with locking tamper-proof setting.
- .2 Circuit balancing valves shall be sized based on design water flow and manufacturer's performance data. Refer to the following circuit balancing valve schedule for sizes.

Size (in)	Nominal Flow			
	Min. (gpm)	Max. (gpm)	Min. (l/s)	Max. (l/s)
1/2	0.6	2.8	0.038	0.177
3/4	2.0	6.0	0.126	0.379
1	3.9	10.0	0.246	0.631
1-1/4	5.0	15.0	0.316	0.947
1-1/2	6.6	20.0	0.416	1.262
2	12.6	36.0	0.795	2.272
2-1/2	38.0	100.0	2.398	6.310
3	31.0	130.0	1.956	8.203
4	68.0	200.0	4.291	12.620
5	90.0	320.0	5.679	20.192
6	182.0	450.0	11.48	28.395

- .3 Acceptable manufacturer is Tour & Anderson (TA Hydronics) only.

2.4 PRESSURE RELIEF VALVES

- .1 Dresser Industries Canada Ltd., "CONSOLIDATED", ASME tested, rated and certified, cast iron, bronze fitted, 1725 kPa rated pressure relief valves, each capable of relieving the full output of the equipment it is associated with, and factory set at 105% (percent) times the system pressure at the point in the system where the pressure relief valve is installed.
- .2 Acceptable manufacturers are Dresser Industries Canada Ltd., Watts Industries, Kunkle, Spirax Sarco Canada Ltd., Singer Valve Co. Ltd., and Lonergan.

2.5 SHUT-OFF VALVES

.1 Ball Type

- .1 Class 600, 4140 kPa (600 psi) WOG rated full port ball valves, each complete with a forged brass or bronze body and cap, blowout-proof stem, solid forged brass chrome plated ball, "Teflon" or "PTFE" seat, threaded ends, and removable lever handle.
- .2 Acceptable products are:
 - .1 Toyo Valve Co. Fig. 5044A;
 - .2 Watts Industries (Canada) Inc. #FBV-3;
 - .3 Kitz Corp. Code 58;
 - .4 Victaulic Co. of Canada Ltd. Series 722;
 - .5 Apollo Valve #77-100.

.2 Butterfly Type

- .1 Cast ductile iron, lug body style, 1200 kPa (175 psi) rated butterfly valve, each complete with a neck to permit 50 mm (2") of insulation above the flange, a field replaceable EPDM seat, ductile iron disc, stainless steel shaft with EPDM seal, a lever handle for valves to and including 150 mm (6") diameter, a handwheel and gear type operator for valves larger than 150 mm (6") diameter, and each suitable for bubble-tight dead end service with valve closed and either side of connecting piping removed.
- .2 Acceptable products are:
 - .1 DeZurik of Canada Ltd., Figure No. 632;
 - .2 Victaulic Co. of Canada Ltd. Vic-300 MasterSeal or AGS Vic-300;
 - .3 Apollo Valve 143 Series;
 - .4 Watts Industries (Canada) Inc. #BF-03;
 - .5 Kitz Corp. 6112 Series;
 - .6 Toyo Valve Co. 918DESL/G2.

2.6 SWING CHECK VALVES

.1 Bronze - Screwed

.1 Class 125, 1380 kPa (200 psi) WOG rated horizontal swing check valves, each complete with a "Y" pattern bronze body, hinged brass disc, easy access screw-in cap, and screwed ends.

.2 Acceptable products are:

.1 Toyo Valve Co. Fig. 236;

.2 Nibco #T-433;

.3 Kitz Corp. Code No. 22.

.2 Cast Iron - Screwed and Flanged

.1 Cast iron, bronze trim, 1380 kPa (200 psi) rated swing check valves, each complete with a bronze disc and seat, malleable iron hinge, bolted cover, and screwed or flanged ends as required.

.2 Acceptable products are:

.1 Toyo Valve Co. Fig. 435A;

.2 Watts Industries (Canada) Inc. #F-511;

.3 Kitz Corp. Code No. 78.

2.7 VERTICAL LIFT CHECK VALVES

.1 Class 150, 1380 kPa (200 psi) WOG rated bronze vertical lift check valves, each complete with screwed ends and a bronze disc.

.2 Acceptable products are:

.1 Toyo Valve Co. Fig. 231;

.2 Watts Industries (Canada) Inc. #600;

.3 Kitz Corp. Code No. 36.

2.8 WAFER CHECK VALVES

.1 Threaded lug body type, full bore, ANSI Series 150, 1965 kPa (285 psi) rated at 38°C (100°F), non-slam wafer check valves, each complete with a carbon steel body, stainless steel discs, a shaft, springs, disc stop and thrust bearings constructed of type 316 stainless steel, and seat materials to suit the application. The inside diameter of the valve must equal the inside diameter of the connecting pipe.

.2 Acceptable products are:

.1 Gulf Valve Co. "WAFER CHECK";

.2 Watts Industries (Canada) Inc. Series ICV-125;

- .3 The Metraflex Co. Style CVXX.

2.9 DRAIN VALVES

- .1 Minimum 2070 kPa (300 psi) WOG rated, 20 mm ($\frac{3}{4}$ ") diameter straight pattern bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm ($\frac{3}{4}$ ") diameter hose, and a cap and chain.
- .2 Acceptable products are:
 - .1 Toyo Valve Co. Ltd. Fig. 5046;
 - .2 Watts Industries (Canada) Inc. #B-6000-CC;
 - .3 Kitz Corp. Code No. 68AC;
 - .4 Apollo Valves #78-104-01.

2.10 RADIATOR SHUT-OFF AND BALANCING VALVES

- .1 Heavy pattern, straight, 1750 kPa (250 psi) rated at 120°C (250°F) bronze radiator valves, each complete with composition disc, spring loaded packing, and union. Equip inlet valves with a handle for shut-off. Equip outlet valves with a lockshield for shut-off and balancing.
- .2 Acceptable products are:
 - .1 Dahl Brothers Canada Ltd. #11042 and #13013;
 - .2 Spirax Sarco Ltd. Type R.

2.11 AIR VENTS

- .1 Manual Air Vents
 - .1 Equal to Conbraco 27 Series, 3.2 mm ($\frac{1}{8}$ ") diameter with a key handle.
- .2 Automatic Air Vents:
 - .1 Float actuated air vents, each complete with a semi-steel body and cap, a stainless steel float assembly and seat, and a neoprene head.
 - .2 Acceptable products are:
 - .1 Spirax Sarco Ltd., Type 13 W for system working pressures to 1035 kPa (150 psi), 13 WH for system working pressures greater than 1035 kPa (150 psi);
 - .2 Armstrong International Inc. No. 1-AV.

2.12 STRAINERS

- .1 Cast iron wye shaped strainers, minimum 890 kPa (125 psi) rated and complete with a removable type 304 stainless steel screen with perforations sized to suit the application, and, for strainers 50 mm (2") diameter and larger, a blowdown pipe connection tapping.
- .2 Acceptable products are:
 - .1 Spirax Sarco Ltd. Type IF-125 screwed or Type AF-250 flanged;
 - .2 Toyo Valve Co. Ltd. Fig. 380A screwed or Fig. 381 flanged;
 - .3 Victaulic Co. of Canada Style 732 or W732 "Vic-Strainer";

- .4 Armstrong International Inc. A1 Series;
- .5 Watts Industries (Canada) Inc. #77SCI;
- .6 Mueller Steam Specialty Products Model 11M screwed or Model 758 flanged.

2.13 FLEXIBLE PUMP CONNECTIONS

- .1 Flexible metal hose assemblies, each complete with annular corrugated unbraided type 321 stainless steel inner core, braided type 321 stainless steel hose, and a collar and flange at each end, all suitable for twice the working pressure of the system.
- .2 Acceptable products are:
 - .1 Senior Flexonics Inc. A1 and A6 Series;
 - .2 The Metraflex Co. Model SST and "METRA-MINI".

2.14 AIR SEPARATOR

- .1 Vortex type vertical air separator with side tangential inlet and outlet connections, a top air outlet connection, and bottom drain connection. Separator is to be constructed of cast iron or fabricated steel for a pressure of 1105 kPa (160 psi) at 180°C (350°F) in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.
- .2 Acceptable products are:
 - .1 S.A. Armstrong Ltd. Model "VA";
 - .2 ITT Bell & Gossett "Rolairtrol";
 - .3 Taco Canada Ltd. "Vortech".

2.15 PLATE TYPE HEAT EXCHANGERS

- .1 Vertical plate type heat exchangers in accordance with drawing schedule, 1035 kPa (150 psi) working pressure rated, factory pressure tested and complete with:
 - .1 electro-galvanized carbon steel frames with baked epoxy enamel finish, same end ANSI 150 flanged connections, a fixed end panel and a removable end panel, and molybdenum greased electro-galvanized steel bolts protected by means of sleeves;
 - .2 type 316 stainless steel plates, fully supported and steered by upper and lower carrying bars to prevent misalignment in both vertical and horizontal directions, space between ports not feeding channels, and channels vented to atmosphere;
 - .3 one-piece snap-on nitrile rubber gaskets moulded in a groove around heat transfer area and plate portholes, and continually supported along inner and outer edges;
 - .4 factory secured seismic restraint connection hardware.
- .2 Acceptable manufacturers are:
 - .1 S. A. Armstrong Ltd.;
 - .2 Alfa Laval Inc.;
 - .3 Baltimore Aircoil of Canada Inc.;
 - .4 Tranter Heat Exchangers (Canada) Ltd.;
 - .5 APV an SPX Brand;
 - .6 Danfoss Inc.;
 - .7 GEA Canada Inc.;
 - .8 Taco (Canada) Ltd.

2.16 EXPANSION TANK

- .1 Replaceable bladder type, factory pressurized expansion tank with permanent separation of air and water, in accordance with drawing schedule and complete with:
 - .1 steel pressure tank suitable for a working pressure of 870 kPa (125 psi) at 115°C (240°F), constructed and stamped in accordance with the ASME Code for Unfired Pressure Vessels and complete with a system connection, drain connection, air charging valve, and a red oxide primer finish;
 - .2 heavy-duty butyl rubber (EDPM) bladder;
 - .3 tapping for installation of a pressure gauge;
- .2 Acceptable products are:
 - .1 S.A. Armstrong Ltd. Series "L"
 - .2 Amtrol "Extrol";
 - .3 Taco (Canada) Ltd. "CA" Series.

2.17 CIRCULATING PUMPS

- .1 Vertical Inline Centrifugal pumps as per the drawing schedule, each non-overloading under all operating conditions and factory tested at specified operating conditions.
- .2 Taco Model KS, split coupled, single stage, vertical in-line pumps shall be complete with:
 - .1 Pump casing shall be constructed of ASTM A48 class 30 cast iron. The pump casing/volute shall be rated for 250 psi working pressure for all jobs. The pump flanges shall be matched to suit the working pressure of the piping components on the job, with either ANSI Class 125 flanges or ANSI class 250 flanges. The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing. The casing shall have an additional tapping on the discharge connection to allow for the installation of a seal flush line. The pump cover shall be drilled and tapped to accommodate a seal flush line which can be connected to the corresponding tapping on the discharge connection, or to an external source to facilitate cooling and flushing of the seal faces.
 - .2 All casings shall be flanged. Threaded casings not allowed unless extra unions and fittings are provided to allow servicing.
 - .3 The pump shall have a factory installed vent/flush line to insure removal of trapped air from the casing and mechanical seal cooling. The vent/flush line shall run from the seal chamber to the pump discharge.
 - .4 The impeller shall be ASTM B584-836/875 bronze and hydraulically balanced. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted to the shaft with a key. The impeller shall be cast by the hydraulically efficient lost foam technique to ensure repeatability of high quality.
 - .5 The pump shall be manufactured with AISI 416 Stainless Steel shaft.

- .6 The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250°F. The mechanical seal shall be an inside type seal yet engineered and applied in a manner that is as or more accessible than a specialty outside seal. This seal must be capable of being flushed externally via a tapping in the pump cover adjacent to the seal cavity. The entire pump line shall use no more than three different sizes of seals. Outside mechanical seals are NOT acceptable.
- .7 The pump shall be coupled via a high tensile aluminum split style coupling. The design must permit easy replacement of the mechanical shaft seal without removal of the motor. The motor mount must be designed to accept several different motor frame standards; CZ and HP. The motor shall be a TEFC, inverter rated motor with class F insulation and shaft grounding ring.
- .3 Taco Model KV, close coupled, single stage, vertical in-line pump complete with:
 - .1 Pump casing shall be constructed of ASTM A48 class 30 cast iron. The pump casing/volute shall be rated for 250 psi working pressure for all jobs. The pump flanges shall be matched to suit the working pressure of the piping components on the job, with either ANSI Class 125 flanges or ANSI class 250 flanges. The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing. The casing shall have an additional tapping on the discharge connection to allow for the installation of a seal flush line. The pump cover shall be drilled and tapped to accommodate a seal flush line which can be connected to the corresponding tapping on the discharge connection, or to an external source to facilitate cooling and flushing of the seal faces.
 - .2 All casings shall be flanged. Threaded casings not allowed unless extra unions and fittings are provided to allow servicing.
 - .3 The pump shall have a factory installed vent/flush line to insure removal of trapped air from the casing and mechanical seal cooling. The vent/flush line shall run from the seal chamber to the pump discharge.
 - .4 The impeller shall be ASTM B584-836/875 bronze and hydraulically balanced. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted to the shaft with a key. The impeller shall be cast by the hydraulically efficient lost foam technique to ensure repeatability of high quality.
 - .5 The pump shall incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft. The pump shaft shall be AISI 1045 carbon steel with field replaceable bronze SAE 660 shaft sleeve. In order to improve serviceability and reduce the cost of ownership the shaft sleeve must be slip on (press on not allowable) and must be easily replaced in the field.
 - .6 The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250°F. The mechanical seal shall be an inside type seal. This seal must be capable of being flushed externally via a tapping in the pump cover adjacent to the seal cavity. The entire pump line shall use no more than three different sizes of seals.
 - .7 Outside mechanical seals are NOT acceptable.
 - .8 The pump shall be close coupled to a JM Frame, TEFC, inverter rated motor with class F insulation and shaft grounding ring.

- .4 Acceptable manufacturers are:
 - .1 S.A. Armstrong Ltd.;
 - .2 ITT Bell & Gossett;
 - .3 Grundfos CBS Inc. PACO;
 - .4 Taco Comfort Solutions.

2.18 GLYCOL SOLUTION MIXING AND STORAGE TANK

- .1 Package type glycol solution mixing, storage and automatic feed assembly designed to maintain minimum system pressure levels and complete with:
 - .1 round, polyethylene or polypropylene tank sized to suit system capacity, complete with a solution level scale in litres and Imperial gallons, removable cover, and a welded steel angle stand assembly with legs, pump shelf, and control panel bracket, all factory finished with enamel;
 - .2 120 volt, 1-phase, 60 Hz electrical connection;
 - .3 factory pre-piped rotary bronze gear pump with capacity and pressure differential to suit system requirements, factory wired to control panel, mounted on a shelf integral with steel stand assembly, and complete with shut-off valve and strainer;
 - .4 tank pressure relief valve with discharge piped back into tank;
 - .5 tank low level switch;
 - .6 pressure gauge;
 - .7 Honeywell #L404A "Pressurtrol" or equal pipe mounting differential pressure switch with a 100 to 1000 kPa (15 to 150 psi) range;
 - .8 factory mounted and pre-wired control panel with a minimum NEMA 2 enamelled steel enclosure, designed to control and operate pump either manually or automatically to pump glycol solution into system, and to stop pump and initiate an audible/visual alarm if a low glycol solution level occurs in tank, and complete with:
 - .1 terminal blocks for power and control wiring connections;
 - .2 H-O-A switch with green "Power On" indicator light;
 - .3 120 volt/12 volt control transformer;
 - .4 low glycol solution level alarm buzzer with silencing switch, an alarm light which remains illuminated until low-level switch is reset, and an alarm push-to-test button;
 - .5 dry contacts for building automation system alarm annunciation.
- .2 Acceptable products are:
 - .1 Calefactio Solutions Series GMP;
 - .2 ITT Bell & Gossett Series GMU;
 - .3 S. A. Armstrong Ltd. Series GLA;
 - .4 Axiom Industries Ltd. Series SF.

2.19 GLYCOL

- .1 Propylene glycol blended with Nitrite based corrosion inhibitors.

3. EXECUTION

3.1 HEATING WATER PIPING INSTALLATION REQUIREMENTS

- .1 Provide all required heating water and glycol solution piping.
- .2 Pipe, unless otherwise noted, shall be mild black steel, Schedule 40 for pipe to 8" (200 mm) diameter, Schedule 30 for pipe 10" to 18" (250 mm to 450 mm) diameter, and Schedule 20 for pipe 20" to 24" (500 mm to 600 mm) diameter.

- .3 Piping to and including 2" (50 mm) diameter shall be screwed. Piping 2-1/2" (65 mm) diameter and larger shall be welded or flanged.
- .4 Slope horizontal mains to provide a minimum continuous up-grade of 1" (25 mm) in 20' (6 m) to high points. Slope branch supply and return piping connections to equipment a minimum of 1" (25 mm) in 4' (1.2 m).
- .5 Provide shut-off valves in piping connections to equipment, to isolate piping risers, to isolate other sections of systems as shown, and wherever else indicated on drawings. Valves in piping to and including 50 mm (2") dia. are to be ball type. All other shut-off valves are to be ball or butterfly type unless otherwise specified. Locate valves so they are easily accessible. Wherever possible, install valves at uniform height. Provide chain operators for valves which are inaccessible for operation from floor level.
- .6 Provide an air relief vent in the high points of closed loop piping systems if the piping is not adequately vented into equipment.
- .7 Provide circuit balancing valves in piping generally where shown on the drawings but with exact locations in accordance with instructions of personnel doing system flow balancing work. Confirm locations prior to installation. Balancing valves shall be sized according to design flow. Ensure that balancing valves are a minimum of 10 pipe diameters downstream of any pump or fitting and a minimum of 5 pipe diameters upstream of any fitting.
- .8 Pipe the discharge of each liquid piping safety relief valve to drain unless otherwise shown or specified.
- .9 Check and test the operation of each liquid piping safety relief valve. Replace defective
- .10 Install automatic control valves, piping wells and similar piping and/or equipment mounted control components required for automatic temperature control systems supplied as part of the work specified the Section 25 05 05. Refer to the drawing control diagrams.

3.2 INSTALLATION OF PRESSURE RELIEF VALVES

- .1 Provide factory set pressure relief valves. Pipe discharge of each water piping relief valve to drain unless otherwise shown or specified.
- .2 Confirm relief valve settings.

3.3 INSTALLATION OF AIR VENTS

- .1 Provide an air vent in piping mains at all high points, at equipment connections, and wherever else shown and/or specified. Equip each air vent with a ball type shut-off valve. Install vents in 100 mm (4") dia. and larger piping and all vents in mechanical rooms in accordance with drawing detail.
- .2 Provide 9 mm (3/8") dia. copper drain piping from each automatic air vent to nearest suitable drain and terminate so discharge is visible. Identify drain piping.

3.4 INSTALLATION OF STRAINERS

- .1 Provide strainers in piping. Locate strainers so baskets are easily accessible and removable. Clean strainer baskets during and after piping system flushing and cleaning is complete, and before water quantity balancing commences.

3.5 INSTALLATION OF CIRCULATING PUMPS

- .1 Provide centrifugal circulating pumps.
- .2 Secure vertical inline pumps in place in accordance with requirements of drawing detail and provide flexible piping connections in vertical suction and discharge piping approximately 450 mm (18") above suction and discharge connection accessories.
- .3 Provide a shut-off valve and suction guide in pump suction piping, and a shut-off valve, check valve and balancing valve in pump discharge piping, installed in accordance with manufacturer's instructions. Remove suction guide start-up strainer screens after piping flushing and cleaning is complete. Valves are to be 150 mm (6") away from pump discharge for discharge piping to 150 mm (6") dia., and 300 mm (12") away from pump discharge for discharge pipe larger than 150 mm (6") dia.
- .4 Supply variable frequency drives (VFD) for pumps as scheduled. Hand VFD's to electrical trade at site for installation as part of the electrical work.
- .5 If circulating pumps are used for piping flushing and cleaning, and pump seal flush line filters are not installed, replace pump mechanical seals when flushing and cleaning is complete.
- .6 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .7 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .8 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.6 INSTALLATION OF EXPANSION TANK

- .1 Provide an expansion tank.
- .2 Secure tank stand to a concrete housekeeping pad by means of machine bolts.
- .3 Connect tank with system piping. Extend a drain line from tank piping and terminate drain line with a drain valve. Provide an air vent.
- .4 Provide a water make-up connection line complete with relief valve and pressure gauge and connect to system piping. Terminate make-up piping for connection to domestic cold water piping as part of the work of Section entitled Domestic Water Piping and Valves. Check relief valve operation and adjust as required.
- .5 Check tank air charge and adjust to suit system air.

3.7 INSTALLATION OF AIR SEPARATORS

- .1 Provide an air separator in piping and connect with valved inlet and outlet piping.

- .2 Extend valved blowdown piping from bottom pipe connection tapping to nearest floor drain location.
- .3 Equip top pipe connection tapping with an automatic air vent, and piping as detailed.

3.8 INSTALLATION OF PLATE TYPE HEAT EXCHANGERS

- .1 Provide plate type heat exchangers.
- .2 Secure each heat exchanger in place, level, and plumb, on a concrete housekeeping pad.
- .3 Connect with piping in accordance with drawing detail.
- .4 When installation is complete and piping has been permanently filled, start-up each heat exchanger, check and test all safeties and operating controls, and set controls to design conditions.
- .5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .6 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .7 Include for a one half day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.9 INSTALLATION OF GLYCOL SOLUTION MIXING AND STORAGE TANK

- .1 Provide a mixing and storage tank and feed assembly for each glycol solution circulating system.
- .2 Secure tank stand to a concrete housekeeping pad. Connect with system piping. Refer to drawing detail.
- .3 Fill tank with, unless otherwise specified, a solution of 50% water, 50% propylene glycol, and test solution to confirm proper concentrations.
- .4 When installation is complete, test operation of assembly, including alarms, and adjust as required. Adjust pressure switch to suit glycol solution circulating system pressure.

3.10 FLUSHING AND CLEANING PIPING

- .1 Flush and clean new piping in accordance with requirements specified in Section entitled HVAC Water Treatment.

3.11 TESTING, ADJUSTING AND BALANCING

- .1 When work is complete and equipment is operating as intended, test, adjust and balance water flows in accordance with requirements specified in Section entitled Testing, Adjusting, and Balancing.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe and fittings.
- .2 Submit, in shop drawing form, a schematic piping diagram for each refrigerant piping system indicating pipe sizes, slopes, valves, traps, and piping specialties. Piping schematics must be reviewed, approved, and signed by refrigeration equipment manufacturers prior to being submitted to Consultant for review.
- .3 Submit letters from equipment suppliers certifying proper installation and start-up of piping systems and equipment as specified in Part 3 of this Section.

1.02 QUALITY ASSURANCE

- .1 Refrigerant piping systems are to be in accordance with CSA B52, Mechanical Refrigeration Code, and any applicable local Codes and Regulations.
- .2 Refrigerant piping installing contractor is to be certified by Technical Standards and Safety Authority (TSSA). Installing contractor is to install refrigerant piping in accordance with manufacturer's installation instructions and in accordance with local codes. Contractor is responsible for all regulatory approvals, if required. Upon completion of installation, documentation of refrigerant amount, test certificates and verification documentation, etc., is to be provided in a binder, in accordance with requirements of local authorities having jurisdiction.
- .3 Refrigerant piping and direct expansion refrigeration equipment must be installed by or under direct on site supervision of a licensed journeyman refrigeration mechanic.

2 PRODUCTS

2.01 PIPE, FITTINGS AND JOINTS

- .1 Type ACR hard drawn seamless copper refrigerant tubing to ASTM B280, factory degreased, dehydrated and capped or nitrogen filled and capped, complete with factory washed and bagged wrought copper soldering fittings to ASME B16.22, and brazed joints made with high melting point silver brazing alloy conforming to AWS Classification BcuP-5.

2.02 PIPING LINE SETS

- .1 Equal to Great Lakes Copper Inc. "EZ-Roll" soft annealed copper to ASTM B280, suitable for use with refrigerant involved, factory cleaned and capped, and with sizes and lengths as required.

2.03 GENERAL RE: VALVES AND PIPING SPECIALTIES

- .1 Refrigerant valves and piping specialties specified below are to factory cleaned, degreased, and supplied to site with capped ends.

2.04 SHUT-OFF VALVES

.1 Ball Valves

- .1 ¼ turn, CSA certified forged brass ball valves, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with carbon filled Teflon ball seals, 2 O-ring stem seals, a gasketed seal cap, a flow direction arrow cast into body, a ball position indicator on stem, and extended copper tube connections to permit brazing the valve into line without disassembling valve.

.2 Acceptable manufacturers are:

- .1 Mueller Industries Inc.;
- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood.

.2 Diaphragm Valves

- .1 Forged brass, frost-proof, Type 1 Series, CSA certified packless diaphragm valves, each suitable for a 3445 kPa (500 psi) working pressure and complete with an O-ring to prevent moisture from entering diaphragm chamber, one phosphor bronze and 2 stainless steel diaphragms, and extended copper tube brazing connections.

.2 Acceptable manufacturers are:

- .1 Mueller Industries Inc.;
- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood.

2.05 CHECK VALVES

- .1 Straight through type for valves 6.4 mm to 16 mm (¼" to 5/8") diameter, globe type for valves 22 mm (7/8") diameter and larger, each complete with extended tubing for brazing connections, and as follows:

- .1 straight through type check valves complete with a machined brass gasketed body, phosphor bronze spring, and neoprene seat;
- .2 globe type check valves complete with a cast bronze body, forged brass cap, phosphor bronze spring, Teflon seat disc, and neoprene O-ring seal.

.2 Acceptable manufacturers are:

- .1 Mueller Industries Inc.;
- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood.

2.06 PIPING TRAPS

- .1 Mueller Industries Inc. Style No. WE-554P brazing end copper "P" traps.
- .2 Acceptable manufacturers are:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

2.07 PRESSURE VESSEL RELIEF VALVES

- .1 Factory set pressure relief valves, straight through or angle type as required, each constructed in accordance with requirements of ANSI B9.1 and the ASME Code for Unfired Pressure Vessels, and each complete with a brass body, neoprene seat disc, and lead seal and locking wire.
- .2 Acceptable manufacturers are:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

2.08 REFRIGERANT LIQUID MOISTURE INDICATORS

- .1 Forged brass, triple sealed, CSA certified liquid moisture indicators, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with a liquid indicator which shows "FULL" when system is fully charged with refrigerant and remains blank when there is a restriction or shortage of refrigerant in liquid line, a moisture indicator which changes colour from blue to pink when moisture is present in system, a plastic dust cover, and extended copper tube brazing connections.
- .2 Acceptable manufacturers are:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

2.09 LIQUID LINE FILTER-DRIER

- .1 Mueller Industries Inc. "Drymaster" CSA certified filter-driers, each suitable for a maximum 3445 kPa (500 psi) working pressure and complete with a combination of desiccants in a fluted briquette for drying, and a fluted briquette type filter.
- .2 Acceptable manufacturers are:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;

- .3 Superior Refrigeration Products/Sherwood.

2.10 FLEXIBLE PIPING CONNECTIONS

- .1 Senior Flexonics Canada "VIBRA-SORBERS" phosphor bronze construction, factory cleaned, dried, and sealed flexible piping connections with copper tube brazing ends.
- .2 Acceptable manufacturers are:
 - .1 Senior Flexonics Canada;
 - .2 The Metraflex Co.

2.11 THERMOSTATIC EXPANSION VALVES

- .1 Factory tested, balanced port design thermostatic expansion valves, with exact selection to suit the application and refrigerant used, each complete within a replaceable stainless steel diaphragm and welded element construction thermostatic element charged with hydraulic fluid, and removable inlet strainer.
- .2 Acceptable manufacturers are:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

3 EXECUTION

3.01 INSTALLATION OF REFRIGERANT PIPING, VALVES AND SPECIALTIES

- .1 Provide required refrigerant piping. Piping is to be type ACR copper with wrought copper fittings. Install piping in accordance with requirements of reviewed refrigerant piping schematics referred to in Part 1 of this Section.
- .2 Make refrigerant piping joints using a light coat of approved brazing flux applied to both pipe and fitting. Do not use acid flux. During brazing process, ensure pipe and fittings are kept full of nitrogen or carbon dioxide to prevent scale formation inside pipe and fitting.
- .3 Where shown or specified, use soft copper refrigerant piping line sets.
- .4 Provide shut-off valves to isolate each piece of equipment if shut-off valves are not supplied integral with equipment. Provide ball or diaphragm type shut-off valves inside building. Provide diaphragm shut-off valves outside building.
- .5 Provide a refrigerant charging valve for each system if such a valve is not supplied integral with equipment.
- .6 Provide refrigerant piping accessories shown and/or required and install in accordance with manufacturer's recommendations.
- .7 Provide required refrigerant.

- .8 Provide flexible connections at piping connections to roof mounted condensing units. Install in accordance with manufacturer's instructions.
- .9 Provide expansion valves where shown and/or required, each matched to coil and installed in accordance with manufacturer's instructions.

END OF SECTION

1 GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all water treatment chemical feed equipment and associated hardware.
- .2 Submit product literature sheets for all chemicals, as well as WHMIS Material Safety Data Sheets for all chemicals.
- .3 Submit water treatment manufacturer/supplier certification letters as specified in Part 3 of this Section.
- .4 Submit water treatment test sets and spare chemicals as specified below and in Part 3 of this Section.

2 PRODUCTS

2.1 CHARACTERISTICS OF CHEMICALS AND SPARE CHEMICALS

- .1 Chemicals specified in this Section are to be non-toxic when released to atmosphere, non-corrosive and non-staining if a leak occurs, and compatible with all system components.
- .2 Chemicals must be approved by governing authorities for release into Municipal sewer system.
- .3 For each treatment system for which chemicals are supplied, supply and hand to Owner, at Substantial Performance of the Work, spare chemical in original containers/packaging sufficient for 2 months of treatment system operation.

2.2 **MANUFACTURERS/SUPPLIERS OF CHEMICALS AND FEED EQUIPMENT**

- .1 Acceptable manufacturers/suppliers are:
 - .1 Ashland Hercules Water Technologies;
 - .2 Klenzoid Inc.;
 - .3 Magnus Canada;
 - .4 Chem-Aqua Canada.

2.3 PIPING SYSTEM FLUSHING AND CLEANING CHEMICAL

- .1 Liquid form alkaline type cleaner consisting of a concentrated blend of highly active penetrating agents and detergents with a 12.5 pH and specifically formulated to remove oil, mill scale and oxides from piping and equipment.

2.4 CLOSED HEAT TRANSFER SYSTEM TREATMENT

- .1 Chemical Bypass Feeders
 - .1 Enamelled steel or cast iron by-pass feeders sized as shown, 2060 kPa (300 psi) rated and complete with 20 mm ($\frac{3}{4}$ ") diam eter NPT pipe connection tapplings, and a screw-on cast iron cap with "Buna N" "O" ring seal.

.2 Chemical Bypass Filter

.1 By-pass filter and flow indicator assembly equal to a Shelco Inc. FOS78, 1725 kPa (250 psi) rated replaceable cartridge filter assembly with a stainless steel housing and 20 mm ($\frac{3}{4}$ ") diameter piping connections, sized for approximately 5% of rated circulating pump flow and complete with a minimum of 6, 20 micron filter cartridges, and a sight flow indicator equal to an Anderson Midwest Model 350SS with 20 mm ($\frac{3}{4}$ ") diameter piping connections.

.3 Piping tee mounting coupon holders, each complete with 25 mm (1") diameter NPT plugs with a minimum of one coupon for copper and one coupon for steel.

.4 Chromate free, nitrite/borate type corrosion inhibitor suitable for use with both ferrous and non-ferrous metals.

.5 Test kit for measuring inhibitor level.

3 EXECUTION

3.1 PIPING SYSTEM FLUSHING AND CLEANING

.1 After new heat transfer system piping has been installed and leakage testing has been satisfactorily completed, but before mechanical equipment start-up and performance tests, flush and chemically clean piping systems. Do not flush/clean existing piping systems.

.2 Provide required temporary piping connections, including bypass piping to isolate dirt sensitive mechanical plant equipment. Remove instrumentation such as flow meters and switches, orifice plates, meter valves and similar devices and plug pipe openings. Reinstall when flushing and cleaning work has been certified complete by chemical manufacturer/installer. Ensure control valves are operational and fully open during flushing and cleaning.

.3 Prior to chemical cleaning, flush piping, including dead ends, with water to remove loose solids. Clean all strainers. Replace chemical feeder line filters as required. Flush and drain until water runs clear.

.4 When flushing with water is complete, fill systems with fresh clean water. Meter amount of water required to fill each system or otherwise calculate system capacity. Ensure all air is vented from systems. Add cleaning chemical as instructed by chemical manufacturer and circulate solution for a period of time and at a temperature as required to produce a clean piping system. Conduct daily pH, conductivity, and total iron tests in accordance with chemical supplier's instructions.

.5 After chemical cleaning when test results indicate a clean system, drain solution from piping, refill with clean water and circulate water for a minimum of 24 hours to flush out remaining chemical solution, then drain water from piping using all drain points and again clean all system strainers and replace filters. Arrange for chemical supplier to check each system after flushing and cleaning is complete and to certify in writing that flushing and cleaning procedures have been properly performed. Submit a copy of the certification letter. Fill systems.

3.2 INSTALLATION OF CLOSED HEAT TRANSFER SYSTEM TREATMENT

.1 After flushing and cleaning procedures have been certified complete, provide a by-pass chemical feeder and a cartridge filter assembly. Install in accordance with requirements of drawing details.

- .2 Supply and feed into each system sufficient chemical to charge system to proper concentrations of chemical, and maintain proper levels in system until Substantial Performance of the Work.

3.3 MANUFACTURER'S CERTIFICATION, START-UP, AND TRAINING

- .1 For all water treatment equipment include for on-site certification, start-up supervision, and system training by treatment chemical manufacturer's representative as follows:
 - .1 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements;
 - .2 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
 - .3 Include for 4 hours of on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

END OF SECTION

1. GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all products specified in this Section except shop fabricated ductwork and fittings.
- .2 Include capacity, throw and terminal velocity, noise criteria, and pressure drops with grille and diffuser shop drawing/product data sheet submission.
- .3 Submit duct leakage test data prior to ductwork being covered from view.
- .4 Include the following with fan & accessories shop drawing/product data sheet submission:
 - .1 certified fan performance curves at specified operating point with flow, static pressure and HP clearly plotted;
 - .2 certified sound power data that conforms to specified levels;
 - .3 product data sheets for all accessories;
 - .4 product data sheets for fan motors.

1.2 QUALITY ASSURANCE

- .1 Grilles and diffusers are to be tested and performance certified to ANSI/ASHRAE 70, Method of Testing the Performance of Air Outlets and Air Inlets.

2. PRODUCTS

2.1 GALVANIZED STEEL DUCTWORK

- .1 Galvanized steel sheet is to be hot dipped in accordance with requirements of ASTM A653. G60 galvanizing for bare uncovered duct to be finish painted. G90 for all other galvanizing.
- .2 Rectangular
 - .1 Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.
- .3 Round
 - .1 Factory machine fabricated, spiral, mechanically locked flat seam, single wall duct, fittings and couplings.

2.2 FLEXIBLE METALLIC DUCTWORK

- .1 Bare
 - .1 Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-UN", ULC S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, and supplied in 3 m (10') lengths.
- .2 Insulated
 - .1 Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-I", ULC S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, supplied in 3 m (10') lengths and factory covered with 40 mm (1-1/2") thick, 12 kg/m³ (0.75 lb/ft³) density fibreglass insulation with a vinyl jacket meeting 25/50 flame spread and smoke developed requirements tested in accordance with CAN/ULC S102.

2.3 FLEXIBLE CONNECTION MATERIAL

- .1 Waterproof, indoor-outdoor type flexible connection material meeting requirements of NFPA 90A, consisting of woven glass fibre fabric coated on both sides with synthetic rubber. Acceptable products are:
 - .1 Duro Dyne Canada Inc. "DUROLON";
 - .2 Dyn Air Inc. "HYPALON".
- .2 Waterproof, flameproof, high temperature flexible connection material meeting requirements of NFPA 90A, consisting of a woven glass fibre fabric coated on both sides with silicone rubber. Acceptable products are:
 - .1 Duro-Dyne Canada Inc. "THERMAFAB";
 - .2 Dyn Air Inc. "SILICON HI-T".

2.4 METAL DUCT SYSTEM JOINT SEALANT

- .1 ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 tested maximum flame spread rating of 5 and smoke developed rating of 0.
- .2 Acceptable manufacturers are:
 - .1 Johns Manville;
 - .2 Manson Insulation;
 - .3 Knauf Insulation.

2.5 ACOUSTIC LINING

- .1 Minimum 25 mm (1") thick acoustic lining material meeting 25/50 flame spread and smoke developed ratings tested in accordance with CAN/ULC S102, meeting NFPA 90A, ASTM C1071, and ASTM G21 requirements, not supporting microbial growth, flexible for round ducts, board type for rectangular ducts, consisting of a bonded fiberglass mat coated on inside (airside) face with a black fire-resistant coating.
- .2 Acceptable manufacturers are:
 - .1 Johns Manville;
 - .2 Manson Insulation;
 - .3 Knauf Insulation.

2.6 CASING AND PLENUM MATERIAL AND ACCESSORIES

- .1 Unless otherwise specified, casing and plenum material is to be same as connecting duct material.
- .2 Accessories such as access doors and drain pans are to be constructed of same material as casing and plenum and are to be in accordance with Chapter 6 of SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.7 AIR FILTERS

- .1 AAF-Canada, air filters as per the drawing schedule. All filters shall be ULC listed and labelled and rated as Class I or Class II.
- .2 Pre-filter shall have a 20-25% average efficiency when tested by the ASHRAE 52 test method. The frame shall be constructed of high strength moisture resistant "beverage" board. Two mating die-cut boxes are bonded together to form a double wall construction. The media pad support retainers shall be bonded to the media on both the air entering and leaving sides.

- .3 Final filters shall have an average efficiency of 90-95%, when tested by the ANSI/ASHRAE 52.1 test method. The Varicel filter shall have cell sides made of natural kraft pine and hardwood fibre board for high tear strength. Two mating die cut boxes shall be bonded together, forming a double wall around the perimeter of the filter. The mini-pleat media pack shall be bonded inside the double wall with a foil laminate frame on all four edges to prevent leakage and increase rigidity. The media shall be dual density micro-glass paper with a water repellent binder. The filters shall have a ULC Class II rating. The efficiency and size shall be as shown on the filter schedule.
- .4 Acceptable manufacturers are Farr, AFF-Canada and Airguard Industries.

2.8 AIR FILTER GAUGES

- .1 Dwyer Industries Inc. Series 2000 differential pressure gauge with a 0-500 Pa range, accurate to within 2% of full scale and complete with all required mounting and connection accessories. The 120 mm diameter dial shall have a zero (0) point adjustment and graduations in inches of wc.

2.9 CASING AND PLENUM MATERIAL AND ACCESSORIES

- .1 Unless otherwise specified, casing and plenum material is to be same as connecting duct material.
- .2 Accessories such as access doors and drain pans are to be constructed of same material as casing and plenum and are to be in accordance with Chapter 6 of SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.10 PLENUM ACCESS DOORS

- .1 Factory fabricated, double wall insulated access doors, sized as indicated on drawings, and constructed of same material as connecting ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit operating pressure of the system.

2.11 SPLITTER DAMPERS

- .1 Minimum #20 gauge damper blade constructed of same material as duct, reinforced as required to suit blade size, system velocity, and to prevent "chatter", and complete with operating hardware equal to DynAir Inc. #Q-50 "DYN-A-QUAD S-S" quadrant regulator with RW-50 backup washers to prevent leakage, long square bearing pin, and slide pin.

2.12 AIR TURNING VANES

- .1 For square elbows, multiple-radius turning vanes interconnected with bars, adequately reinforced to suit pressure and velocity of system, constructed of same material as duct they are associated with, and in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.13 MANUAL BALANCING (VOLUME) DAMPERS

- .1 Flanged and drilled, single or parallel blade (depending on damper size) manual balancing dampers, each constructed of same material as connecting ductwork unless otherwise specified, each designed to maintain internal free area of connecting duct, and each complete with:
 - .1 hexagonal or square shaft extension through frame;
 - .2 non-stick, non-corrosive synthetic bearings for rectangular dampers, flange stainless steel bearings for round dampers;

- .3 blade stops for single blade dampers, designed to prevent blade from moving more than 90°;
 - .4 linkage for multiple blade dampers;
 - .5 locking hand quadrant damper operator with, for insulated ducts 50 mm (2") standoff mounting.
- .2 Rectangular Dampers: Nailor Industries Inc. 1800 Series, maximum size 1.2 m x 1.2 m (4' x 4') for a single damper.
 - .3 Round Dampers: Nailor Industries Inc. Model 1890, maximum 600 mm (24") diameter, equipped with a minimum 200 mm (8") deep frame, and blade stiffeners where required.
 - .4 Multiple Rectangular Damper Section Assembly: Rectangular assembly supplied with the dampers or site constructed, of same material as damper and designed for tight and secure mounting of individual dampers.
 - .5 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 T.A. Morrison & Co. Inc. "TAMCO";
 - .3 NCA Manufacturing Ltd.;
 - .4 Greenheck Fan Corp.;
 - .5 Ruskin Co.

2.14 BACKDRAFT DAMPERS

- .1 Nailor Industries Inc., 1300 Series gravity type dampers each complete with a galvanized steel frame, aluminum damper blades with neoprene edges, galvanized steel linkage, and lifetime lubricated nylon bearings.
- .2 Acceptable manufacturers are Nailor Industries Inc., Greenheck Fan Corp., NCA Manufacturing Limited, Ruskin Ltd., and Air Specialties Manufacturing Ltd.
- .3 SMACNA HVAC Duct Construction Standards Metal and Flexible, to suit the pressure construction standard of the system.

2.15 FUSIBLE LINK DAMPERS

- .1 Curtain blade type, dynamic, galvanized steel (unless otherwise specified) fusible link dampers, ULC classified to CAN/ULC S112 and in accordance with NFPA 90A requirements, factory tested for closure under airflow, 1-1/2 hour or 3 hour rated as required, and complete with a constant force type 301 stainless steel closure spring, a blade lock assembly, a steel sleeve, retaining angles, and, unless otherwise specified, a 74°C (165°F) rated standard fusible link.
- .2 Fusible link dampers are to be Type "B" or Type "C" (as required) with folded curtain blade out of air stream except where damper size or location requires use of type "A" dampers with curtain blade in air stream.
- .3 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 Greenheck Fan Corp.;
 - .3 NCA Manufacturing Ltd.;
 - .4 Ruskin Co.;
 - .5 Price Industries (E.H. Price).

2.16 COMBINATION FIRE/SMOKE DAMPERS

- .1 Nailor Industries Series 1220, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator.
- .2 For applications where supply or return ducts terminate at a grille, at your option, provide:
 - .1 Nailor Industries 1221-OW "out of wall" high performance combination fire/smoke damper, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator accessible through the front supply/return grille, intumescent thermal insulation on all sides of sleeve.
 - .2 Nailor Industries 1221G combination fire/smoke damper for grilles, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator accessible through the front supply/return grille, grille mounting flanges. Coordinate grille size and mounting with damper requirements.
- .3 ULC 1-1/2 hour fire rated and ULC Class I leakage rated for smoke, and equipped with a 74°C (165°F) ULC classified fusible link that will cause damper to close and lock independent of actuator when duct temperature reaches maximum temperature of damper assembly.
- .4 Supply damper with factory installed sleeves of minimum 400 mm (16") length, field verified by contractor dependent on wall thickness. Caulk sleeves to ULC requirements and constructed of 20 gauge for sizes up to 2.1 m (84") wide and 18 gauge for sizes greater than 2.1 m (84") wide.
- .5 Dampers in ductwork other than galvanized steel are to be as specified above but constructed of type 316 stainless steel.
- .6 Acceptable manufacturers are:
 - .1 Nailor Industries Inc.;
 - .2 Greenheck Fan Corp.;
 - .3 NCA Manufacturing Ltd.;
 - .4 Ruskin Co.;
 - .5 Price Industries (E.H. Price);
 - .6 United Enertech.

2.17 MOTORIZED DAMPERS

- .1 TAMCO Series 9000 BF low leakage/thermal break thermally insulated air foil damper capable of achieving a 6.7 cfm/sq. ft. (34 l/s/sq. m.) at - 40 °F (- 40 °C) leakage rate at 4" (1 kPa) differential pressure and bearing the AMCA certification seal for air leakage and complete with:
 - .1 0.080" (2.03 mm) thick 4" (100 mm) deep extruded aluminium insulated frame with extruded TPE thermoplastic seals on the sides of the frame. Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts;
 - .2 extruded aluminium, broken frame damper blade internally insulated with non-CFC expanded polyurethane foam, with EPDM gasketed blade seals integrally secured to the damper blade;
 - .3 acetal copolymer (Celcon) and polycarbonate bearings with no metal-to-metal contact;
 - .4 out-of-airstream linkages and crank arms constructed of aluminium and corrosion resistant, zinc & nickel plated steel, complete with cup-point trunnion screws.

- .2 Dampers shall be sized for "flanged" installation (damper blade area to be equal to duct or plenum cross section area).
 - .3 Acceptable damper manufacturer is TAMCO only.
- 2.18 ROOF DUCT SUPPORTS
- .1 Equal to PHP Systems Design Model PHP-D adjustable duct support assemblies sized to suit duct size, each assembly complete with injection moulded recycled plastic and carbon black bases and tubular hot dip galvanized steel framing.
- 2.19 ROUND TO RECTANGULAR DUCT CONNECTIONS
- .1 Equal to Flexmaster Canada Ltd. galvanized steel, flared, flanged or notched "Spin-On" round duct take-off collars with locking dampers in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- 2.20 DUCT ACCESS DOORS
- .1 In accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, with sizes suitable in all respects for purpose for which they are provided, and, unless otherwise specified, constructed of same material as duct they are associated with.
- 2.21 DUCTWORK DRAIN POINTS
- .1 Equal to Ductmate Canada Ltd. "Moisture Drain", 20 mm ($\frac{3}{4}$ ") diameter moisture drains with galvanized sheet metal funnel, and chrome plated brass threaded drain, nut and cap.
- 2.22 INSTRUMENT TEST PORTS
- .1 Equal to Duro-Dyne of Canada Ltd. #IP1 or #IP2 (to suit insulation thickness where applicable) gasketed, leakproof instrument test ports for round or rectangular ducts as required, each complete with a neoprene expansion plug and a plug securing chain.
- 2.23 WIRE MESH (BIRDSCREEN)
- .1 Heavy-gauge galvanized steel or aluminum mesh, 12 mm x 12 mm ($\frac{1}{2}$ " x $\frac{1}{2}$ ") secured in a rigid galvanized steel or aluminum framework, sized as indicated on drawings, and constructed so as to be removable.
- 2.24 LOUVRES
- .1 Price Industries Inc. DE439 or DE635, 100 mm (4") or 150 mm (6") deep (to suit wall thickness) factory assembled stationary, drainable, storm-proof louvres sized as indicated on drawings, each AMCA water penetration and air performance certified, constructed of welded, extruded, alloy 6063-T5 aluminum with drainable blades, mounting and securing hardware to suit the application, and 12 mm ($\frac{1}{2}$ ") mesh aluminum birdscreen in an aluminum frame.
 - .2 Louvres are to be factory finished with a finish equal to PPG Industries "Duramar" fluoropolymer powder coating over primer with colour as selected from manufacturer's standard colour range.
 - .3 Acceptable manufacturers are:
 - .1 Price Industries Inc.;
 - .2 The Airolite Co. LLC;
 - .3 Construction Specialties;
 - .4 Nailor Industries Inc.;
 - .5 Greenheck Fan Corp.

2.25 LOUVRE BLANK-OFF PANELS

- .1 Insulated, framed, sandwich construction panels consisting of 40 mm (1-½") thick rigid insulation (meeting NFPA 90A requirements) between minimum #20 gauge galvanized sheet steel with exterior face of panels finished to match finish of exterior wall louvres.

2.26 GRILLES AND DIFFUSERS

- .1 Grilles and diffusers of type, size, capacity, finish, and arrangement as shown on drawings and in accordance with drawing schedule, each equipped with all required mounting and connection accessories to suit mounting location and application.
- .2 Acceptable manufacturers are:
 - .1 Price Industries Inc.;
 - .2 Anemostat;
 - .3 Krueger Division of Air System Components Inc.;
 - .4 Titus;
 - .5 Nailor Industries Inc.;
 - .6 Tuttle & Bailey.

2.27 LOUVRED PENTHOUSE TYPE VENTILATORS

- .1 Low silhouette, rectangular, roof mounting louvred penthouse type hoods in accordance with drawing schedule, each constructed of aluminium, supplied in knock-down form for site assembly, and each complete with:
 - .1 extruded aluminium, welded storm-proof louver blades with mitred corners and stainless steel securing screws;
 - .2 removable cover for internal access, lined with glass fibre insulation material and equipped with stainless steel fasteners;
 - .3 12 mm x 12 mm (½" x ½") aluminium mesh birdscreen;
 - .4 welded aluminium, minimum 300 mm (12") high insulated roof mounting curb with damper tray and curb seal;
- .2 Acceptable manufacturers are:
 - .1 Greenheck Fan Corp.;
 - .2 Twin City Fan and Blower;
 - .3 PennBarry.

3. EXECUTION

3.1 CLEANLINESS REQUIREMENTS FOR HANDLING AND INSTALLATION OF DUCTWORK

- .1 Handle and install ductwork in accordance with SMACNA's Duct Cleanliness for New Construction Guidelines at the Advanced Level.

3.2 GENERAL RE: FABRICATION AND INSTALLATION OF DUCTWORK

- .1 Provide required ductwork, rectangular, round and/or flat oval. Where rectangular ductwork is shown, round or flat oval ductwork of equivalent cross-sectional area is acceptable.
- .2 It is to be understood that all duct dimensions shown on drawings are clear internal dimensions.

- .3 Unless otherwise specified, construct and install ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct pressure class designation of minimum 500 Pa (2" w.c.) positive or negative as applicable, a minimum velocity of 10 m/s (2000 fpm), and so ductwork does not "drum". Flat surfaces of rectangular ductwork are to be cross-broken. Duct system sealing is to meet ANSI/SMACNA Seal Class A requirements.
- .4 Construct ductwork so that manufacturer's gauge markings are external, and, unless otherwise specified, construct, seal and install ductwork in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible to suit the duct pressure class designation. Sealing for ductwork with a pressure class less than 0.45 kPa shall be SMACNA Seal Class "C".
- .5 Confirm routing of all ductwork at site and site measure ductwork prior to fabrication. Duct dimensions may be revised to suit site routing and building element requirements, if dimension revisions are reviewed with and approved by Consultant. Duct routing and/or dimension revisions to suit conditions at site are not grounds for a claim for an extra cost.
- .6 Refer to structural drawings. Where ductwork is to be run within or through open web steel joists, ductwork shown on mechanical drawings is schematic only and is to be altered as required to suit steel joist configuration, spacing, panel points, and cross-bridging at no additional cost.
- .7 Wherever ductwork is required at locations where sprayed fireproofing is applied to building construction, install ductwork only after fireproofing work is complete and do not compromise fire rating of sprayed fireproofing.
- .8 Install (but do not connect) duct system mounted automatic control components supplied as part of the automatic control work.
- .9 Support horizontal rectangular ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but use trapeze hangers with, unless otherwise specified, galvanized steel channels, and galvanized steel hanger rods for exposed ducts and concealed ducts wider than 500 mm (20"). Support hardware constructed of same material as duct for metal duct, and, unless otherwise specified, type 316 stainless steel for non-metal duct. Supports for "heavy" duct such as cementitious core duct is to be suitable in all respects for the application and approved by Consultant.
- .10 Support round and flat oval ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at top of duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA". If duct is insulated, size strap to suit diameter of insulated duct. Unless otherwise specified, duct support hardware for metal duct is constructed of same material as duct, and for non-metal duct, type 316 stainless steel.
- .11 Factory made flanged joint system components are acceptable in rectangular duct installations. Install the components in strict accordance with the manufacturer's printed instructions and recommendations.
- .12 Where flanged duct joints are used, do not locate joints in wall or slab openings, or immediately at wall or slab openings. Do not use flanged joints for exposed uninsulated ducts in finished areas.
- .13 Where watertight horizontal ductwork is required, construct ducts without bottom longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide drain points. Provide watertight ductwork for:

- .1 ductwork outside building or otherwise exposed to the elements;
 - .2 shower exhaust ducts from grilles to duct main or riser;
 - .3 fresh air intakes;
 - .4 wherever else shown.
- .14 Ductwork leakage shall not exceed the following:
- .1 ductwork to 2" W.C. Class - one (1) percent of the total air quantity handled by the respective fans;
 - .2 ductwork exceeding 2" W.C. Class - two (2) percent of the total air quantity handled by the respective fans.
- .15 Leakage testing of ductwork shall be provided by the Testing, Adjusting and Balancing (TAB) agency in accordance with the requirements of SMACNA "HVAC Air Duct Leak Test Manual" and as specified herein. In addition, be responsible for the following:
- .1 preparing ductwork 25' (7.5 m) and longer, for leakage testing prior to installation of external insulation including capping duct runouts and provision of tap-in for test equipment;
 - .2 Ensuring notice is given to the TAB Agency and Commissioning Consultant so that they may be present for all testing;
 - .3 resealing and/or replacement of defective ductwork;
 - .4 bearing all costs associated with retesting ductwork which has failed to pass leakage testing.
- .16 Seal all ductwork in accordance with SMACNA Seal Class "A", except for round duct with self-sealing gasketed fittings and couplings which does not require site applied sealant. Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.
- .17 Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.
- .18 Clean exterior exposed (uninsulated) ducts and coat with a heavy full coverage of Bakor #410-02 black metal paint.
- .19 Where dissimilar metal ducts are to be connected, isolate ducts by means of flexible duct connection material.
- .20 Round exposed ductwork in Gymnasium is to be 2 metal gauges heavier than standard metal gauge for same size duct, and duct hangers are to be pairs of 9.5 mm ($\frac{3}{8}$ ") diameter hanger rods secured to 40 mm (1- $\frac{1}{2}$ ") wide #12 gauge galvanized steel split clamps around full circumference of duct at maximum 1.8 m (72") centres. Provide double nuts and lock washers on each hanger rod above and below each clamp.
- .21 Provide automatic control dampers, except for dampers supplied as part of the cabinet fan assemblies. Leave each damper in satisfactory condition.
- .22 Ensure that control dampers located in aluminium ductwork are constructed of type 316 stainless steel and are non-corrosive.
- .23 Refer to Section entitled Basic Mechanical Materials and Methods for additional installation requirements.

3.3 INSTALLATION OF FLEXIBLE DUCTWORK

- .1 Provide maximum 3 m (10') long lengths of flexible ductwork for connections between galvanized steel duct mains and branches, and necks of ceiling grilles and diffusers. Do not install flexible ductwork through walls, even if shown on drawings.
- .2 At rectangular galvanized steel duct, accurately cut holes and provide flanged or "Spin-in" round flexible duct connection collars. Seal joints with duct sealer.
- .3 Install flexible ducts as straight as possible and support in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, and secure at each end with nylon or stainless steel gear type clamps, and seal joints. Provide long radius duct bends where they are required.
- .4 Do not penetrate fire barriers with flexible duct.

3.4 INSTALLATION OF ACOUSTIC LINING

- .1 Provide acoustic lining in ductwork in locations as follows:
 - .1 wherever shown and/or specified on drawings;
 - .2 supply ductwork downstream of air terminal boxes for a distance of 2.4 m (8') measured along duct and outward from box in all directions;
 - .3 all transfer air ducts.
- .2 Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel in accordance with detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.

3.5 INSTALLATION OF CASINGS AND PLENUMS

- .1 Provide required shop or site fabricated casings and plenums. Unless otherwise specified or shown, construct casings and plenums of same material as connecting duct system.
- .2 Construct and install casings and plenums in accordance with Chapter 6 of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit systems' pressure classification. Ensure plenums and casings secured to building structure are gasketed air-tight and equipped with angle reinforcing.
- .3 Provide drain pans with accessible trapped drains for fresh air intake plenums, and wherever else shown.

3.6 INSTALLATION OF CASING AND PLENUM ACCESS DOORS

- .1 Provide access doors into all site or shop fabricated casings and plenums requiring access, and wherever shown.
- .2 Construct access doors to open in or out to suit positive and negative pressures of system.
- .3 Provide pitot tube openings in access doors where required for system air quantity balancing purposes.
- .4 Provide suitably sized, engraved, red-white laminated Lamacoid warning nameplates on access doors into casings and plenums where equipment is located, i.e. fans.

3.7 INSTALLATION OF ROUND TO RECTANGULAR DUCT CONNECTIONS

- .1 Cut round holes in rectangular ducts and provide round to rectangular lock-in fittings with dampers for connection of flexible round ductwork.

3.8 INSTALLATION OF SPLITTER DAMPERS

- .1 Provide splitter dampers in supply ductwork at branch duct connections off supply air mains, and wherever else shown and/or specified on drawings. Install splitter dampers so they cannot vibrate and rattle and so damper operation mechanisms are in an easily accessible and operable location. Ensure operators for dampers in insulated ducts are equipped with stand-off mounting brackets.

3.9 INSTALLATION OF TURNING VANES

- .1 Provide turning vanes in ductwork elbows where shown on drawings and wherever else required where, due to site installation routing and duct elbow radius, turning vanes are recommended in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

3.10 INSTALLATION OF MANUAL BALANCING (VOLUME) DAMPERS

- .1 Provide manual balancing dampers as required to provide a fully balanced system, including but not limited to in all open end ductwork, in all duct mains, and wherever else shown and/or specified.
- .2 Install dampers so operating mechanism is accessible and positioned for easy operation, and so dampers cannot move or rattle. Ensure operating mechanisms for dampers in insulated ducts are complete with stand-off mounting brackets.
- .3 Where a duct for which a balancing damper is required has dimensions larger than dimensions of maximum size volume damper available, provide multiple dampers bolted together in a properly sized assembly, or bolted to a heavy-gauge black structural steel angle or channel framework which is properly sized. Seal to prevent air by-pass, and provide connecting linkage.
- .4 Confirm exact damper locations with personnel doing air quantity balancing testing work and install dampers to suit. Include for providing 5 additional dampers at no additional cost.

3.11 INSTALLATION OF BACKDRAFT DAMPERS

- .1 Provide backdraft dampers where shown.
- .2 Install and secure such that the dampers cannot move or rattle.

3.12 INSTALLATION OF FUSIBLE LINK DAMPERS

- .1 Provide fusible link dampers. Ensure damper rating (1-½ or 3 hr.) is suitable for fire barrier it is associated with.
- .2 Install dampers with retaining angles on all 4 sides of sleeve on both sides of damper and connect with ductwork in accordance with damper manufacturer's instructions and details, and Code requirements.
- .3 Provide expansion clearance between damper or damper sleeve and opening in which damper is required. Ensure openings are properly sized and located, and all voids between damper sleeve and opening are properly sealed to maintain rating of fire barrier.
- .4 Where size of fire barrier opening requires use of a sectionalized fire damper assembly, provide multiple fusible link dampers (sized to CAN/ULC S112) bolted together in a properly sized assembly or bolted to a heavy-gauge black structural steel angle or channel framework.

3.13 INSTALLATION OF COMBINATION FIRE/SMOKE DAMPERS

- .1 Provide combination fire/smoke dampers. Install dampers with retaining angles on all 4 sides of each side of damper, and, where required, connect with ductwork, all in accordance with damper manufacturer's instructions and details, and Code requirements.
- .2 Coordinate damper installation with electrical work where electrical connections to damper actuators are specified.

3.14 INSTALLATION OF FLEXIBLE CONNECTION MATERIAL

- .1 Provide a minimum of 100 mm (4") of flexible connection material where ducts, plenums, and/or easings connect to fans, and wherever else shown or specified.
- .2 Rigidly secure a minimum of 75 mm (3") of duct material (minimum #24 gauge) to each edge of flexible fabric and to fan, duct, plenum, etc., in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Ensure connections to flexible fabric material are arranged and supported so as to not impose any external forces on the fabric.

3.15 INSTALLATION OF ROOF MOUNTED DUCT SUPPORTS

- .1 Supply supports for roof mounted ductwork.
- .2 Hand adjustable structural supports to roofing trade on roof for installation and flashing into roof construction as part of roofing work. Accurately mark exact locations and spacing of structural supports and supervise installation. Provide properly sized hot dip galvanized structural steel angles between structural supports and secure in place on support studs. Support ductwork on the angles and provide galvanized steel banding to secure ducts to the angles.

3.16 INSTALLATION OF PRESSURE RELIEF DOORS

- .1 Provide pressure release access doors to prevent duct system explosion or implosion as a result of a duct obstruction, i.e. closed fire damper, which prevents normal air flow through the system. Size access doors in accordance with requirements of Part 2 of this Section.
- .2 Where pressure release doors are shown in suction ducts or plenums, mount access door assembly so door swings in and latch mechanism is on the inside of duct or plenum. If latch mechanism is not accessible, provide a standard access door at latch side of the pressure release access door for maintenance purposes.
- .3 Adjust each latch mechanism by means of the adjusting pin to suit static pressure of the particular system in accordance with latch mechanism manufacturer's instructions.

3.17 INSTALLATION OF DUCT ACCESS DOORS

- .1 Provide access doors in ductwork for access to all components which will or may need maintenance and/or repair, including reheat coils. Install in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Identify access doors provided for fusible link damper maintenance with "FLD" stencil painted or marker type red lettering and ensure doors are properly located for damper maintenance.
- .3 When requested, submit a sample of proposed duct access doors for review.
- .4 Where sectionalized fusible link dampers and/or balancing dampers are provided in large ducts, provide a plenum type access door to suit, and adequately reinforce ductwork to suit access door installed.

3.18 INSTALLATION OF INSTRUMENTS TEST PORTS

- .1 Provide instrument test ports in all main ducts at connections to fans, plenums or casings, in all larger branch duct connections to mains, and wherever else required for proper air quantity balancing and testing.
- .2 Locate test ports where recommended by personnel performing air quantity testing and balancing work.

3.19 INSTALLATION OF ACOUSTIC LINING

- .1 Provide acoustic lining to the extent shown and/or specified on the drawings.
- .2 Install lining in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.

3.20 INSTALLATION OF AIR FILTERS

- .1 Provide all required air filters, located and arranged as shown and scheduled.
- .2 Provide all required filter assembly frames and install to prevent air by-pass and to permit easy filter removal. Construct frames from the same material as the plenum, casing or duct the filters are associated.
- .3 When air handling systems are complete and ready for start-up and testing, but building finishes are not complete and cleaning is not complete, provide minimum 20% average dust spot efficient (atmospheric) temporary glass fibre media in place of permanent filters prior to fan start-up, and provide temporary media over all return air openings in dirty, dusty, incomplete areas.
- .4 Prior to application for a Certificate of Substantial Performance, and when the systems are ready for air balancing, remove temporary media and install permanent filters.
- .5 For each filter bank, supply a spare set of replacement media and turn the filters over to the Project Manager prior to application for a Certificate of Substantial Performance of the Work.

3.21 INSTALLATION OF AIR FILTER GAUGES

- .1 Provide a filter gauge for each main air handling system. For systems with pre-filters and after-filters, install the gauge across the after-filters.
- .2 Secure gauges in place on the filter section casing in an easily readable location. Adjust each gauge to suit the design pressures of the system with new fresh filters in place.

3.22 INSTALLATION OF WIRE MESH (BIRDSCREEN)

- .1 Provide framed, removable wire mesh panels over openings in ducts and/or walls where shown and/or specified on drawings. Rigidly secure in place but ensure panels are removable.
- .2 Provide wire mesh panels for open-end return air ducts in ceiling spaces whether shown on drawings or not.

3.23 INSTALLATION OF LOUVRES

- .1 Provide louvres for wall openings.
- .2 Install louvre assemblies and secure in place in accordance with manufacturer's instructions and details.
- .3 Confirm exact louvre sizes and finish prior to ordering.

3.24 INSTALLATION OF LOUVRE BLANK-OFF PANELS

- .1 Provide blank-off panels for inactive portions of exterior wall louvres.
- .2 Secure panels in place with non-ferrous hardware so they cannot move or rattle, yet are easily removable.
- .3 Confirm exact finish of panels prior to fabrication.

3.25 INSTALLATION OF GRILLES AND DIFFUSERS

- .1 Provide grilles and diffusers. Wherever possible, grilles and diffusers are to be product of same manufacturer.
- .2 Unless otherwise specified connect grilles and diffusers in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .3 Exactly locate grilles and diffusers to conform to final architectural reflected ceiling plans and detailed wall elevations, and to conform to final lighting arrangement, ceiling layout, ornamental and other wall treatment.
- .4 Equip supply diffusers having a basic 4-way or all round air pattern for operation in 1-, 2-, or 3-way pattern where indicated on drawings.
- .5 Confirm grille and diffuser finishes prior to ordering.

3.26 DUCT SYSTEMS CLEANING AND START-UP

- .1 Remove all dirt and foreign matter from the entire duct system and clean duct system terminals and the interior of supply air handling units prior to operating fans.
- .2 Prior to starting any supply air handling system provide 50 mm (2") thick glass fibre construction filters at fan equipment in place of permanent filters.
- .3 Provide cheesecloth over all duct system inlets and outlets inside the building and run the system for twenty-four hours, after which remove the cheesecloth, the construction filters, and install new permanent filters.
- .4 Include all labour for a complete site walk-through with testing and balancing personnel following the route of all duct systems to be tested, adjusted and balanced for the purpose of confirming the proper position and attitude of dampers, the location of pitot tube openings, and any other work affecting the testing and balancing procedures. Perform all corrective work required as a result of this walk-through.

3.27 TESTING, ADJUSTING AND BALANCING

- .1 Testing, adjusting and balancing of air distribution work shall be performed by a balancing contractor retained directly by the Board and is not included in the mechanical contracts.
- .2 The mechanical contractor shall co-operate with the balancing contractor and provide whatever assistance the balancing contractor may require in order to complete the work.
- .3 Prepare the systems for balancing as follows:
 - .1 check the operation of fan equipment, automatic dampers, and similar air flow control devices and ensure that they are operating properly;
 - .2 ensure that air filters are new and clean;
 - .3 ensure that any required duct leakage testing has been completed and that the duct systems are air-tight within tolerances specified in this Section.

- .4 Perform all corrective work such as fan sheave replacement and duct sealing recommended by the Balancing Personnel.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop product data sheets for silencers. Include all construction, acoustic and aerodynamic performance data, and details with submission. Acoustical data is to demonstrate that duct systems with silencers will reduce mechanical fan system noise to required levels in occupied spaces.
- .2 Submit manufacturer's test data to indicate results of factory tests on the silencers prior to shipment.
- .3 Submit a copy of the silencer manufacturer's National Voluntary Laboratory Accreditation Program (NVLAP) accreditation certificate for latest ASTM E477 test standards.
- .4 Submit an installation certification letter from silencer manufacturer as specified in Part 3 of this Section.

1.02 QUALITY ASSURANCE

- .1 Silencer performance must be substantiated by laboratory testing in a duct-to-reverberant room test facility according to ASTM E477, Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Material and Prefabricated Silencers.
- .2 Silencer acoustic media and any lining/wrapping material must have a maximum flame spread rating of 25 and a smoke developed rating of 50 when tested in accordance with CAN/ULC S102, Surface Burning Characteristics of Building Materials, and Accessories.
- .3 Acceptable silencer manufacturers are:
 - .1 Vibro-Acoustics Ltd.;
 - .2 Kinetics Noise Control Vibron Products Group;
 - .3 VAW Systems Ltd.;
 - .4 Price Industries Inc.

2 PRODUCTS

2.01 GENERAL RE: SILENCERS

- .1 Silencers are to be factory fabricated by same manufacturer and are to be in accordance with drawing schedule, and tested in accordance with ASTM E477 through National Voluntary Laboratory Accreditation Program (NVLAP) with valid accreditation certificate.
- .2 Silencer inlet and outlet dimensions are to be equal to duct sizes shown on drawings. Unless otherwise shown or specified, transitions will not be permitted.
- .3 Silencers are to be constructed in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible, to suit duct system pressure and velocity classification. Unless otherwise specified, casing seams and joints are to be lock-formed and sealed or stitch welded and sealed, and silencers are to be constructed so as not to fail when subjected to an internal static pressure of 3.9 kPa (8" wg).

- .4 Perforated steel is to be adequately stiffened to ensure flatness and form, and welds are to be shop painted with zinc rich paint.
- .5 Silencers are to be shipped with factory installed end caps.
- .6 Galvanized steel is to be in accordance with ASTM A653.

2.02 OUTER CASING MATERIALS

- .1 Rectangular Straight and Transitional Straight Silencers: Minimum #22 gauge lock forming quality galvanized steel.
- .2 Elbow and Transitional Elbow Silencers: Minimum #18 gauge for elbow lock forming quality galvanized steel.
- .3 High Transmission Loss (HTL) Rectangular and Elbow Silencers: # 16 or #10 gauge stitch-welded and caulked galvanized steel in accordance with drawing schedule.
- .4 Circular Silencers: Lock forming quality galvanized steel with minimum gauges as follows:
 - .1 300 mm to 660 mm (12" to 26") dia. - #22 gauge;
 - .2 675 mm to 1.52 m (27" to 60") dia. - #18 gauge;
 - .3 1.55 m to 2.13 m (61" to 84") dia. - #16 gauge.

2.03 INTERIOR BAFFLE-LINER-BULLET MATERIAL

- .1 Minimum #22 gauge lock forming quality galvanized steel.

2.04 INTERIOR BAFFLE TRANSITION

- .1 Transitioning for interior transition silencers is to occur internal to silencer such that height of air passage is uniformly changing with the length of the air passage.

2.05 ACOUSTIC MEDIA MATERIAL

- .1 Acoustic quality insulation which does not contain any formaldehydes, phenolic resins, or volatile organic compounds that can off-gas, but containing cotton fibres treated with an EPA registered non-toxic borate solution, "flash dried" to actively inhibit the growth of mould, mildew, bacteria, and fungi.

2.06 ACOUSTIC MEDIA PROTECTION MATERIAL

- .1 Material for lining/wrapping acoustic media to help prevent shedding and erosion, in accordance with drawing schedule, is to be:
 - .1 polymer film material separated from perforated metal liner with a 12 mm (½") thick acoustically transparent spacer;

2.07 HIGH TRANSMISSION LOSS CASINGS

- .1 High transmission loss (HTL) casings for silencers as scheduled are to be externally shop applied, and completely sealed to silencer casing. HTL walls are to consist of media, air space, mass, and an outer protective metal skin as required to obtain room noise criteria.

3 EXECUTION

3.01 INSTALLATION OF SILENCERS

- .1 Provide silencers. Ensure silencers are installed with airflow arrows in the direction of airflow.
- .2 Support each silencer independent of connecting ductwork.
- .3 Properly layout ductwork for silencer locations to provide a minimum of 5 diameters of straight duct upstream of silencer and 10 diameters of straight duct downstream of silencer.
- .4 Unless otherwise specified, do not install silencers in walls or slabs.
- .5 Seal all silencer connections to ducts with proper fire/smoke rated duct sealer.
- .6 When silencer installations are complete, arrange, and pay for silencer manufacturer to examine silencer installations. Perform any corrective work required by manufacturer, then obtain from manufacturer and submit a signed letter certifying proper installation and operation of all silencers.

END OF SECTION

1 GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings/product data sheets for heat recovery ventilators, including accessories, and all required power and control wiring schematics.
- .2 Submit with delivery of each unit a copy of the factory inspection report, and include a copy of each report with O & M Manual project close-out data.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .4 Supply a spare filter set for each ventilator and store at site where directed prior to Substantial Performance of the Work.
- .5 Submit a signed extended warranty direct from manufacturer to Owner covering the energy recovery wheel from material and workmanship defects for an additional 4 years after Contract warranty expires.
- .6 Supply reviewed copies of ventilator/curb assembly shop drawings or product data to trade who will cut roof openings for ventilators, and ensure openings are properly located.

1.2 QUALITY ASSURANCE

- .1 Energy recovery ventilator manufacturers are to be current members of Air Movement and Control Association International Inc. (AMCA), and fans are to be rated (capacity and sound performance) and certified in accordance with requirements of following standards:
 - .1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;
 - .2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;
 - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;
 - .4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;
 - .5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans;
 - .6 AHRI Standard 1060, Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment;
 - .7 ASHRAE 84, Method of Testing Air-to-Air Heat/Energy Exchangers;
 - .8 UL 1812, Ducted Heat Recovery Ventilators;
 - .9 CSA or ETL certification for all electrical components.

.2 Acceptable manufacturers are:

- .1 Aldes;
- .2 Mitsubishi Electric;
- .3 LG;
- .4 Greenheck Fan Corp.;
- .5 Loren Cook Co.;
- .6 Renewaire.

2 PRODUCTS

2.1 ENERY RECOVERY VENTILATORS

- .1 Factory assembled, internally wired energy recovery ventilators in accordance with drawing schedule, and with AHRI certified energy recovery ratings.
- .2 Interior Unit Casings and Frame: Internal frame type casing constructed of heavy-gauge G90 galvanized sheet steel with interior surfaces lined with 25 mm (1") thick, 24 kg/m³ (1-½ lb./ft.³) density coated glass fibre duct lining material meeting 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, Surface Burning Characteristics of Building Materials and Assemblies, and installed with all exposed edges tucked under flanges. Additional features and requirements as follows:
 - .1 casings complete with factory sealed metal-to-metal joints, a solid integral base with up-turned lips around bottom openings, separate openings and knock-outs for power and control wiring conduit connections, top panels, where joints are required, are to be equipped with a standing seam, and all metal exposed to weather is to be factory cleaned, primed, and finished with baked enamel;
 - .2 removable gasketed panels or hinged gasketed access doors provided for access to all interior components;
 - .3 stainless steel drain pan pitched for positive drainage and equipped with captive condensate drain pipe connection.
- .3 Enthalpy type energy recovery wheel for both sensible and latent heat recovery, designed to ensure laminar air flow, with energy transfer ratings in accordance with ASHRAE 84 and AHRI certified to AHRI 1060, designed to transfer moisture entirely in vapour phase, consisting of removable segments for larger wheels, and complete with:
 - .1 silica gel desiccant permanently bonded to lightweight polymer media mounted in a stainless steel rotor;
 - .2 bearings selected for a minimum L-10 life in excess of 400,000 hours;
 - .3 high-strength urethane drive belt factory installed in a pre-stretched state, and a motor conforming to requirements specified in Section entitled Basic Mechanical Materials and Methods;
 - .4 frost control protection with an electric pre-heater.

- .4 Disposable glass fibre media filters, ULC listed Class 2, side removable, 50 mm (2") thick, pleated, MERV 13 rating, factory or field installed in a die-formed galvanized steel filter rack at air intake opening.
- .5 Centrifugal, draw-through within reference to the energy recovery wheel, double width and inlet exhaust and supply fans with forward curved blades, belt driven or direct driven as indicated, statically and dynamically balanced, mounted to unit base with neoprene vibration isolation, and equipped with:
 - .1 ground and polished steel fan shafts mounted in permanently lubricated sealed ball bearing pillow blocks selected for a minimum L-10 life in excess of 200,00 hours at maximum operating speed;
 - .2 motors and where indicated, belt drives conforming to requirements specified in Section entitled Basic Mechanical Materials and Methods.
- .6 Each ventilator is to be equipped with a sealed and factory pre-wired control box containing terminal blocks for power and control wiring connections, integral door interlocking disconnect switch, an overload protected contactor for each motor, fuses, and 24 VAC secondary control transformer.
- .7 Control system in accordance with drawing control schematic/sequence, and to include if indicated, all required hardware and circuitry for connection into building automation system using protocol as specified with the system.

3 EXECUTION

3.1 INSTALLATION OF ENERGY RECOVERY VENTILATORS

- .1 Provide energy recovery ventilator.
- .2 Provide hangers for mounting of energy recovery ventilator.
- .3 Coordinate power wiring connection and provision of a disconnect switch for each ventilator in accordance with electrical work Specification where power wiring is specified.
- .4 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .6 Include for a ½ day on-site heat recovery ventilator operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full heat recovery ventilator internal inspection, construction details, operation, maintenance, abnormal events, and setting up controls.

END OF SECTION

1 GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings/product data sheets for fans and accessories. Include following:
 - .1 certified fan performance curves at specified operating point with flow, static pressure and HP clearly plotted;
 - .2 certified sound power data that conforms to specified levels;
 - .3 product data sheets for all accessories;
 - .4 product data sheets for fan motors.
- .2 Submit with delivery of each unit a copy of the factory inspection report, and include a copy of each report with O & M Manual project close-out data.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .4 Supply reviewed copies of fan/curb assembly shop drawings or product data to trade who will cut roof openings for fans, and ensure openings are properly located.
- .5 Submit a signed copy of de-stratification fan manufacturer's 5 year extended parts and labour warranty.

1.2 QUALITY ASSURANCE

- .1 Fan manufacturers, as applicable, are to be current members of the Air Movement and Control Association International Inc. (AMCA), and fans are to be rated (capacity and sound performance) and certified in accordance with requirements of following standards:
 - .1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;
 - .2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;
 - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;
 - .4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;
 - .5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans.

2 PRODUCTS

2.1 CENTRIFUGAL INLINE FANS

- .1 Centrifugal, ULC listed, factory run tested rectangular inline fans in accordance with drawing schedule.

- .2 Heavy-gauge galvanized steel housing with removable side panels to permit removal of power assembly without disturbing duct connections, universal mounting brackets and hardware including spring vibration isolators to accommodate horizontal or vertical mounting as required, a flanged inlet panel with inlet venturi, a flanged outlet panel, both with duct connection collars, and galvanized steel wire grid fan inlet/outlet guard(s).
- .3 Non-overloading aluminium wheel with backward inclined blades with matching inlet venturi, statically and dynamically balanced as an assembly.
- .4 For belt-drive fans only, hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and heavy-duty, self-aligning pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 500,000 hours and equipped with lubrication line and fitting, and an adjustable V-belt drive with guard conforming to requirements of Section entitled Basic Mechanical Materials and Methods.
- .5 TEFC motor conforming to requirements specified in Section entitled Basic Mechanical Materials and Methods, mounted out of the airstream, complete with a cover, and factory pre-wired to a NEMA 4 disconnect switch.
- .6 For fans as scheduled, factory supplied accessories as follows:
 - .1 for fans as scheduled, housing insulation (lining), consisting of neoprene spray coated glass fibre semi-rigid insulation meeting NFPA 90A requirements and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, permanently secured in place with no exposed edges;
 - .2 for fans as scheduled, a galvanized steel filter box with frame suitable for 25 mm (2") thick disposable panel type filters;
- .7 Acceptable manufacturers are:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 Carnes Company Inc.;
 - .5 Soler & Palau.

2.2 ROOF MOUNTED EXHAUST FANS

- .1 Centrifugal, ULC listed, factory run tested roof mounted exhaust fans in accordance with drawing schedule.
- .2 Spun aluminium housing with deep venturi inlet, aluminium curb cap with continuously welded corners, pre-punched mounting holes, galvanized steel or aluminium birdscreen, and EMT conduit chase to the motor compartment.
- .3 Centrifugal, non-overloading aluminum wheel with backward inclined blades matched to inlet venturi, statically and dynamically balanced as an assembly.

- .4 For belt-drive fans only, hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and one-piece grease lubricated pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 500,000 hours at maximum catalogue operating speed and equipped with a lubrication fitting, and a heavy-gauge galvanized steel adjustable V-belt drive with guard conforming to requirements of Section entitled Basic Mechanical Materials and Methods.
- .5 Motors are to conform to requirements specified in Section entitled Basic Mechanical Materials and Methods, mounted on vibration isolation in a compartment outside of the airstream, and factory pre-wired to a NEMA 4 disconnect switch.
- .6 Prefabricated, minimum 300 mm (12") high heavy-duty aluminum roof mounting curb with factory installed wood nailer, 40 mm (1-½") thick insulation, continuously welded seams, and damper tray.
- .7 For fans as scheduled, factory supplied accessories as follows:
 - .1 gravity backdraft damper with #20 gauge galvanized steel frame and #26 gauge aluminum blades with felt edge blade seals;
 - .2 non-corrosive motorized damper with linkage, end switch, and motor with voltage to match fan motor;
 - .3 continuous non-corrosive piano type curb hinge to permit access to fan, damper and connecting duct, complete with retaining chain and a security hasp to prevent removal of unit from curb cap and prevent building entry through connecting ductwork;
 - .4 2-speed switch and 2-speed double winding 1-phase motor in accordance with Section entitled Basic Mechanical Materials and Methods;
- .8 Acceptable manufacturers are:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 Carnes Company Inc.;
 - .5 Soler & Palau.

3 EXECUTION

3.1 INSTALLATION OF CENTRIFUGAL INLINE FANS

- .1 Provide inline centrifugal fans.
- .2 Secure each fan in place from structure with vibration isolation, independent of connecting ductwork and in accordance with fan manufacturer's instructions.
- .3 Ensure duct connections are made using flexible connection material.

- .4 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .6 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.2 INSTALLATION OF ROOF MOUNTED EXHAUST FANS

- .1 Provide roof mounted exhaust fans.
- .2 Supply a roof mounting curb with each fan and hand curbs to roofing trade on roof for mounting and flashing into roof construction as part of roofing work. Secure fans in place on curbs.
- .3 Install dampers in curb damper tray and secure in place.
- .4 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .6 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

END OF SECTION

1. GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 20 05 05.
- .2 Submittals shall include the following: performance and capacity details of all units at specified indoor and outdoor conditions, piping schematics outputted from manufacturer specific software including pipe sizes and estimated piping lengths, refrigerant charge per system including CSA B52 analysis, wiring diagrams, and 10 year parts only warranty information.
- .3 Submittal shall include a copy of the installing contractor's certification of VRF manufacturer approved training.

2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers of Condensing Units are:
 - .1 Daikin – Rebel Applied;
 - .2 AAON;
 - .3 LG;
 - .4 Mitsubishi Electric.

2.2 GENERAL DESCRIPTION

- .1 All units shall be listed and rated by ANSI/AHRI Standard 1230-2010 and meet all minimum IEER performance requirements as scheduled.
- .2 The units shall be ANSI/UL 60335-2-40 listed and listed by Electrical Testing Labs (ETL) and bear the cETL label.
- .3 All wiring shall be in accordance with the National Electric Code (NEC)/Canadian Electrical Code (CEC).
- .4 The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- .5 The system and the design shall be in compliance with CSA B52:23 Mechanical Refrigerant Code.
- .6 Alternate manufacturers shall send approval requests to consultant 14 days prior to bid day, and include all information relevant to the alternate VRF system, including but not limited to: unit selections, refrigerant piping layout, refrigerant charge with CSA B52 analysis, branch selector box layout and locations, heating and cooling capacities at design temperatures and including capacity losses from piping lengths, defrost cycles, and combination ratios, dimensional and weight differences, and any other aspect of the system that differs from the system specified.

2.3 SYSTEM DESCRIPTION

- .1 VRF system shall automatically vary the target evaporating and condensing temperatures

based on building load and weather conditions to increase part load efficiency (Variable Refrigerant Temperature). The condensing unit shall also feature customizable operating modes which allows for the manual setting of target evaporating and condensing temperatures.

- .2 System shall be a two pipe heat pump switchover VRF system. All indoor units on single refrigerant circuits shall operate in the same mode (heating or cooling). The specified system is not a simultaneous heating and cooling heat recovery system. Refer to the controls section of this specification for any central controller and/or mode switchover sequence that may be required.

2.4 START-UP AND WARRANTY

- .1 Installing contractor must be certified by VRF manufacturer. The bidders shall be required to submit training certification proof with bid documents and submittal documents. Untrained contractors who wish to bid this project may contact DXS Ontario (416-661-3400) to arrange training prior to bid day.
- .2 The manufacturer shall provide a factory trained service technician to start-up each unit. Manufacturer shall provide instruction to the owners' personnel on proper unit operation and maintenance.
- .3 The warranty period on all parts and compressors shall commence on the date of initial start-up and shall continue for a period of Ten (10) years not to exceed one hundred and twenty six (126) months from date of shipment. Proper maintenance of the equipment shall be conducted by certified technicians as per the manufacturer or manufacturer's representative requirements. Maintenance logs shall be supplied by the owner upon request.
- .4 All manufacturer warranty shall be for parts only. All diagnosis and labour warranty shall be carried out by installing contractor as per the warranty requirements of this project.

2.5 REFRIGERANT PIPING

- .1 Refer and comply to the refrigerant piping specifications, including the special considerations for VRF refrigerant piping section.
- .2 Standard T style joints are not acceptable for a variable refrigerant volume system. Manufacturer specific Y joints shall be supplied by the VRF manufacturer.

2.6 AIR HANDLING UNIT INTEGRATION

- .1 DX COIL
 - .1 Certification - Acceptable refrigerant coils are to be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.
 - .2 VRV systems, where indicated, are to be integrated with make-up air unit(s), utilizing a factory installed VRF DX coil, electronic expansion valves and appropriate controls. VRV manufacturer shall provide the DX coil(s), electronic expansion valves and controllers.
 - .3 Coils designed for use with Refrigerant R-32. Fins shall have a minimum thickness of

0.0075" of aluminum plate construction with full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tube shall not be visible between fins.

- .4 Refrigerant coils shall be provided with round seamless 3/8" O.D. copper tubes on 1-1/2" centers, staggered in the direction of airflow. All joints shall be brazed.
- .5 Sweat type copper suction connections located at the bottom of the suction headers for gravity oil drainage. Coils shall be uniformly circuited in a counterflow manner for interlaced face split capacity reduction. Pressure type liquid distributors used. Coils shall be tested with 315 pounds air pressure under warm water, and suitable for 250 psig working pressure.

2.7 EXPANSION VALVE

- .1 VRF system shall monitor and maintain the unit superheat (cooling mode) or subcooling (heating mode) using a computerized PID control. Internal unit components shall be factory wired and piped, and complete with electronic proportional expansion valve, flare connections, condensate drain pan, self-diagnostics, and auto-restart function.
- .2 Expansion 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°C (2°F) of saturated suction temperature at evaporator conditions. Pilot-operated valves shall have a characterized plug to provide required modulating control.
- .3 Electronic expansion valves shall be brass body, needle valve with floating needle and machined seat, stepper motor drive and compatible with R32 and PVE oil.
- .4 Electronic expansion valves shall have a temperature operation of -40F to 300F.
- .5 Electronic expansion valves shall have a working pressure of 550 psig and should be able to handle up to 700psig
- .6 The access port of the expansion valve must be on the valve body and not on the piping
- .7 Electronic expansion valves shall be able to handle the flow without any pressure drop
- .8 Electronic expansion valves shall be able to work with bi-directional flows

2.8 CONDENSING UNITS

- .1 The condensing unit shall be factory assembled in North America and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of Daikin inverter scroll compressors, motors, fans, heat exchanger, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver (heat recovery only) and suction accumulator.
- .2 The system will automatically restart operation after a power failure and will not cause any

settings to be lost.

- .3 The unit shall incorporate an auto-charging feature to ensure proper refrigerant charge.
- .4 The following safety devices shall be included on the condensing unit: high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter, and anti-recycling timers.
- .5 The Daikin inverter scroll compressors shall be high efficiency reluctance DC (digitally commutating), hermetically sealed, variable speed type. Temperatures and pressures shall be read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value. Non inverter-driven compressors shall not be accepted.
- .6 Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. Upon complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
- .7 The compressors' motors shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
- .8 Inverter board shall be refrigerant-cooled to prevent inefficient and unstable operation that can result from air-cooled inverter boards due to varying ambient conditions.
- .9 The compressor shall be internally isolated to avoid the transmission of vibration.
- .10 In the case of multiple condenser modules, operation hours of the compressors shall be balanced by means of the Duty Cycling Function.
- .11 AIR COOLED
 - .1 The variable speed inverter compressors in Air-Cooled systems shall also use Flash Vapor injection technology with back pressure control for reduced leakage and additional balancing weights on main shaft for increased for increased compressor lifetime.
 - .2 The fan motor shall have inherent protection and permanently lubricated bearings. The motor shall be provided with a fan guard to prevent contact with moving parts. The condensing unit shall consist of one or more propeller type, direct-drive 600 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
 - .3 Motors shall be capable of delivering design air at high external static pressures up to 0.32 in WG (factory set as standard at 0.12 in. WG) to accommodate field applied condensing unit discharge ductwork.
 - .4 The condensing unit shall have configurable settings for intermittent fan operation to help minimize snow accumulation on fan blades when the system is off.
 - .5 Night setback control for low noise operation shall automatically limit the maximum speed of the fan motor.
 - .6 The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tubes with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design. The heat exchanger coil shall be of a waffle louver fin and rifled bore

tube design to ensure high efficiency performance.

- .7 The fins are to be covered with an anti-corrosion hydrophilic blue coating as standard with a salt spray test rating of 1000hr (ASTM B117 & Blister Rating:10), Acetic acid salt spray test of 500hr (ASTM G85 & Blister Rating:10).
- .8 The connection ratio of indoor units to condensing unit shall be permitted and optimized for operation up to 200% of nominal capacity.

.12 VRV Emerion (VRV Emerion Air-Cooled Systems)

- .1 Condensing unit shall be factory provided with the ability to be installed in phases as part of a tenant fitout or core and shell project.
- .2 Multi-module systems shall have the ability to be "valved off" and isolated for start-up and operation with less than 50% connection ratio. Proper design and pre-planning is required.
- .3 System refrigerant piping shall be capable of being sized to accommodate current and future indoor units without any changes to main piping riser. Any changes to piping shall be the responsibility of the installing contractor.
- .4 Condensing units shall be connectable to Daikin Communicating gas furnaces with AFUE ranging from 80% to 97%.
- .5 The system shall be able to switch between heat pump heating and gas furnace heating at a field selectable change-over temperature which can be configured via condensing unit field settings.
- .6 Systems shall have a vertical (height) separation of up to 361 ft between the condensing unit and the indoor units.
- .7 Each condensing unit shall include a multi-functional digital display that can provide system operation status such as operating refrigerant temperatures, pressures, outdoor electronic expansion valve opening and compressor operation time.
- .8 Each condensing unit shall include a service window that can provide easy access to system field settings and operation status without completely removing the condensing unit panel.
- .9 Each system shall include a built-in data recorder that can store up to 45 minutes of operational data which can help identify the issue in case of a product failure.
- .10 Condensing units shall be specifically designed and built for cold climate applications, where the VRF system will be a reliable source of heating. Condensing units shall have heating capacity and efficiency data down to -22F.
- .11 The outdoor coil shall have a three-circuit heat exchanger design. The lower part of the coil shall be a hot gas base pan circuit to prevent ice buildup in the drain pan, allowing installation without additional drain pan heaters. Manufacturers without hot gas base pan circuits shall provide a drain pan heater accessory, installed and wired by contractor.
- .12 The outdoor unit shall be capable of cooling operation down to +23°F without any additional low ambient controls.

- .13 The outdoor coil shall have a three-circuit heat exchanger design. The lower part of the coil shall be used for inverter cooling, enhancing defrost during heating operation.

2.9 LOCAL CONTROLS

- .1 VRV systems, where indicated, are to be integrated with air handling unit(s), utilizing a VRF DX coil, electronic expansion valves and appropriate controls. VRV manufacturer shall provide the DX coil(s), electronic expansion valves and expansion valve controllers.
- .2 Expansion valves, expansion valve controllers, and thermistors shall be factory mounted, powered, and wired on the air handling unit(s). Thermistors shall be factory mounted in the appropriate airstream and both liquid and suction refrigerant lines.
- .3 Expansion valves and expansion valve controllers shall be certified in accordance with UL 60335-2-40 for the use of R32.
- .4 R32 refrigerant leak sensors shall be factory installed and tested in accordance with UL 60335-2-40 and CSA B52 2023. The leak detection system shall be able to output a leak signal to shut down any associated VRF condensers and trigger any associated building alarms in the event of a leak.
- .5 VRF expansion valve controllers shall provide return air temperature or discharge air temperature control. The expansion valve controller shall communicate with the AHU or BAS controller via MODBUS, and be capable of (but not limited to) the following:
 - .1 The discharge air temperature shall be controlled via the Discharge Temperature Target, adjustable from 10C to 40C in 0.1C increments.
 - .2 The VRF shall be enabled and disabled via the System Operation MODBUS point.
 - .3 The VRF systems mode of operation (cooling/heating) shall be controlled by the Coil Operation Mode MODBUS point
 - .4 Alarms or errors with the VRF system shall be communicated over MODBUS by the expansion valve controller
 - .5 Expansion valve controller shall provide an interlocking fan signal over MODBUS to the AHU or BAS controller. Modulation of ventilation device by others.
 - .6 Expansion valve controller shall be wired to and communicate with the VRV condensing units via the H1, H2 ports
- .6 A navigation remote similar to BRC1NRV71 shall be installed to facilitate system commissioning, changing field settings, and simplified diagnostics.
- .7 Connection of air handling unit DX coils to non-VRV condensing units (which do not include inverter compressors) shall not be acceptable.
- .8 All VRV condensing units on the project, for the VRV indoor units and for the air handling units, shall be from the same manufacturer.

2.10 ELECTRICAL

- .1 Independent electrical power for fan coils and branch selector boxes shall be 208/230 volts, 1

phase, 60 hertz. The unit shall be capable of operating within the limits of 187 volts to 253 volts.

- .2 Unless limited by local electrical codes and standards, multiple fan coils and branch selector boxes can be connected to the same breaker. Field provided individual disconnect switches for each fan coil are required.
- .3 Electrical power for condensing units shall be 208/230 volts, 3 phase, 60 hertz. The unit shall be capable of operating within the limits of 187 volts to 253 volts.
- .4 The control voltage between the indoor and outdoor unit shall be 16VDC. The control wiring shall be communication type stranded non-shielded 18-2 AWG.
- .5 Control wiring shall be installed in a daisy chain configuration between all VRF components as per Manufacturer.

3. EXECUTION

3.1 INSTALLATION OF SEMI-CUSTOM ROOFTOP UNITS

.1 DELIVERY, STORAGE AND HANDLING

- .1 Units shall be stored and handled according to the manufacturer's recommendations. Units shall be kept clean and isolated from dust and debris.
- .2 Contractor shall inspect all equipment upon delivery and notify shipping company and manufacturer immediately of any damage.

.2 INSTALLATION

- .1 Install condensing units on a flat surface level within 1/8 inch, and elevated a minimum of 18" from ground or roof surface. Provide intermediate supports as recommended by the equipment manufacturer.
- .2 Provide all necessary control wiring as recommended by the manufacturer.
- .3 High/low pressure gas line, liquid, and suction lines must be individually insulated between the outdoor and indoor units.
- .4 Contact manufacturer prior to installation to review and confirm piping layout and lengths.
- .5 Use refrigeration best practice to allow pipes to expand and contract freely. Review manufacturer installation instructions to ensure expansion joints are properly designed.
- .6 Pressure test ALL systems to 550 PSI after system was vacuumed and held to below 500 microns for at least one hour. Review manufacturer installation instructions for proper pressure test procedures.
- .7 Carefully coordinate installation of each unit with all other trades making connections to unit, in particular, power, interlock connections, and control connections.
- .8 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .9 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.

- .10 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, with abnormal events.

END OF SECTION

1. GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all make-up air units. Include following:
 - .1 certified fan performance curves;
 - .2 certified sound power data;
 - .3 computer generated psychrometric chart for each cooling coil;
 - .4 hardware for section-to-section site connections;
 - .5 dimensioned layouts, including dimensioned curb layouts as applicable;
 - .6 product data for fan motors.
- .2 Submit with delivery of each unit a copy of the factory inspection and fire test report as specified in Part 2 of this Section, and include a copy of each report with O & M Manual project close-out data.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .4 Submit spare air filters as specified in Part 2 of this Section.

1.2 QUALITY ASSURANCE

- .1 Air handling units and installation are to be in accordance with requirements of the following:
 - .1 all applicable Provincial Codes and Standards;
 - .2 CAN/CSA B149, Natural Gas and Propane Installation Codes;
 - .3 CSA or ETL listed and labelled electrical components.
- .2 Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- .3 Air handling units shall be ETL-Canada safety listed to conform to UL Standard 1995 and CAN/CSA Standard C22.2 No. 236. Air handling unit water heating & cooling coils shall be certified in accordance with the forced circulation air cooling and air heating coils certification program, which is based on ARI Standard 410.
- .4 Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- .5 Unit shall be certified by ETL and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label. The nameplate, safety labels and warnings will be in English and French.

1.3 WARRANTY

- .1 The warranty period shall commence at the date of initial start up and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include parts only.
- .2 Manufacturer shall furnish a factory trained service technician to perform the unit start-up assistance to the installing contractor with licensed gas personnel. Factory technician to provide copy of start-up log to owner and to demonstrate operation and maintenance to owner's representative.

2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers of Semi-Custom Indoor Units are:
 - .1 Daikin – Vision;
 - .2 AAON.

2.2 CASING

- .1 Fabricate unit with 16 gauge nominal channel posts and panels secured with mechanical fasteners. All panels and access doors shall be sealed with bulb-type gasket.
- .2 Panels and access doors shall be constructed as a 2-inch (50-mm) nominal thick, thermal broke double wall assembly, injected with foam insulation for an R-value of not less than R-13. The outer casing shall be constructed of heavy gauge G90 galvanized steel phosphatized and painted with baked on enamel.
- .3 The inner liner shall be constructed of G90 galvanized steel. Panel deflection shall not exceed L/240 at 125% of design static pressure, minimum +/- 8". Deflection shall be measured at the midpoint of the panel height.
- .4 The casing leakage rate shall not exceed 0.5 cfm per square foot of cabinet area at 6 inches of negative static pressure or 5 inches of positive static pressure.
- .5 Access doors shall be flush mounted to the cabinetry and secured with heavy-duty stainless steel hinges. The door latch handle assembly shall be provided with a full-size grip handle and roller pall for smooth operation. The assembly shall be gasketed and sealed to prevent thermal bridging. All access doors shall open against pressure. (Provide inspection window for each access door).
- .6 Construct drain pans from stainless steel with cross break and pitch to drain connection. Provide drain pans under cooling coil section and humidifier sections.
- .7 All outdoor units mounted on roof curbs with openings to the conditioned space below, shall be designed with a drip shield under the unit to catch and remove any potential moisture created by condensation.
- .8 Provide unit with a factory installed full perimeter channel base rail.
- .9 Floor plate shall be constructed of 20 gauge G90 galvanized steel.

2.3 MIXING SECTION & ECONOMIZER SECTION

- .1 Provide mixing box sections with factory mounted low leak airfoil outside and return air dampers of galvanized steel in galvanized frame. Dampers shall be hollow core airfoil blades, fully gasketed. Provide continuous vinyl seals between damper blades. Provide stainless steel end seals along end of dampers. Provide linkage and ABS plastic end caps provided.
- .2 Provide economizer section with factory mounted low leak hollow core airfoil blade outside, and return dampers, and exhaust damper. Dampers shall be constructed of galvanized steel in galvanized frame. Provide fully gasketed outside exhaust, and return dampers. Provide continuous vinyl seals between damper blades. Provide stainless steel end seals along end of

dampers. Provide linkage and ABS plastic end caps.

- .3 Damper leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate shall be tested in accordance with AMCA Standard 500.

2.4 FILTERS

- .1 Provide filter box section with filter guides, hinged and latching access doors as shown on drawings, for side loading of filters. Where applicable, front loading filters shall be accessed via upstream access section.
- .2 Filter media shall be UL 900 listed, Class I or Class II.
- .3 Provide extended surface filter box with holding frames suitable for (2") MERV 8 pleated panel prefilter and (4") MERV 13 final filter, media and blank-off sheets, extended surface cartridge media filters.
- .4 Provide Minihelic filter gauges for each filter bank flush mounted into unit casing with factory mounted probes.

2.5 FANS

- .1 Provide forward curved or air foil fans as scheduled. Dynamically balance fans before and after installation in fan cabinet section. Ensure maximum fan RPM is below the first critical speed fan.
- .2 Locate fan and motor internally on a steel base. Factory mount motor on a slide base that can be slid out of unit. Provide access to motor, drive and bearings through hinged access door. Provide fan and motor assembly mounted on (2") deflection spring vibration isolators inside cabinet.
- .3 Provide self-aligning, grease lubricated, ball or roller bearings with extended copper lubrication lines to access side of unit. Provide grease fittings attached to fan base assembly near access door.
- .4 Bearings and Drives (not applicable to fan array)
 - .1 Provide bearings with basic load rating computed in accordance with AFBMA - ANSI Standards, L-50 life at 200,000 hours, heavy duty pillow block type, self-aligning, grease-lubricated ball bearings.
 - .2 Provide solid, hot rolled steel, ground and polished shaft, protectively coated with lubricating oil.
 - .3 Provide variable pitch sheaves on all motors 7 1/2 HP and lower. Provide constant pitch sheaves on all motors greater than 7 1/2 HP sizes V-belt drive for a service factor of 1.25. On constant pitch units, allow for one sheave change including belts (parts only, labour by balancing contractor).
- .5 Provide TEFC premium efficiency motors.

2.6 COILS

- .1 Provide access to coils as shown on drawings for service and cleaning. Enclose coil headers and return bends fully within unit casing. Fabricate coil connections, vents and drains to extend beyond unit casing including grommets for an airtight unit casing. Coils shall be removable through side panels and/or top panels of unit without removal and disassembly of entire

section.

- .2 Provide stainless steel drain pan located underneath and extending downstream of coil and intermediate drain pans.
- .3 Coil performance shall be as per schedule. Coil performance data shall be certified in accordance with ARI Standard 410 where applicable.
- .4 Construction:
 - .1 Tubes: Copper.
 - .2 Fins: Aluminum mechanically bonded to tubes.
 - .3 Headers: Seamless copper with vent and drain connections.
 - .4 Casing: 16 gauge, galvanized steel channels with 16 gauge center and end supports.
- .5 Water cooling and heating coils shall be circuited drainable with a vent connection at the highest point and a drain connection at the lowest point. Coil headers shall be copper with steel male pipe connections.
- .6 Refrigerant cooling coils shall be designed for use with Refrigerant noted in schedules. Sweat type copper suction connections shall be located at the bottom of the suction headers for gravity oil drainage.

2.7 ACCESS

- .1 Provide access doors of galvanized steel flush mounted, with gasket, latch and handle assembly. Provide stainless steel drip pan in access section.

2.8 ENERGY RECOVERY WHEEL

- .1 Provide enthalpy wheels factory installed in units where scheduled.
- .2 Energy recovery wheel shall be constructed of corrugated synthetic fibrous media. All surfaces shall be coated or uniformly bound with a non-migrating absorbent specifically developed for the selective transfer of water vapor.
- .3 Media shall be engineered to provide corrosion resistance and resistance against attack from laboratory chemicals present in pharmaceutical, hospital, etc. environments as well as attack from external outdoor air conditions. The rotor media shall be capable of being cleaned with low temperature steam without degrading unit performance.
- .4 The desiccant material shall be a molecular sieve, and specifically a 4A or smaller molecular sieve to minimize cross contamination.
- .5 The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. Adjustable brush seals must be provided along the periphery of the rotor and between the inlet and outlet air passages to effectively prevent air leakage and cross-contamination between airflows.
- .6 Cassettes shall be fabricated of heavy duty reinforced galvanized steel or welded structural box tubing. Cassettes shall have a built in adjustable purge section minimizing cross contamination of supply air. Bearings shall be inboard, zero maintenance, permanently sealed roller bearings, or alternatively, external flanged or pillow block bearings.
- .7 The rotor drive system shall consist of a self-adjusting belt around the rotor perimeter driven by an AC motor with gear reduction. The variable speed drive shall be specifically designed for

heat wheel applications and include: an AC inverter, soft start/stop, rotation detection w/alarm contacts, automatic self-cleaning jog cycle, and self-testing capability. The speed controller shall be capable of accepting a potentiometer, VDC, or mA control signal.

- .8 The wheel shall be ARI certified by the energy recovery wheel supplier to ARI Standard 1060 and must bear the ARI certification stamp. Private independent testing performed "in accordance with" various standards is not a substitute for ARI certification and shall not be accepted. The wheel shall be listed or recognized by UL or equivalent.

2.9 GAS HEATING SECTION

- .1 Where shown on plans, furnish and install a Gas-fired Section. Furnace shall have a minimum thermal efficiency of 80%. The module shall employ tubular heat exchangers with a draft inducer assembly to provide for positive venting of flue gases.
- .2 Tubular heat exchanger shall be constructed of 16 gauge, minimum, type 304 stainless tubes, 2 1/4" diameter having a minimum tube wall thickness of .049" and shall be produced to ASTM A249 construction standards for heat exchanger application. Tubes shall employ integral formed-dimple restrictors to eliminate noise associated with expansion and contraction of internal baffles during heating cycles, and to provide for unobstructed drainage of condensate that occurs in the tubes during cooling operation. Drainage shall be configured so that burners and burner surfaces are not exposed to condensate during cooling system operation.
- .3 The furnace shall have the modulating control. Shall control the firing rate between 25% and 100% of rated capacity. Stepped modulation is not acceptable.
- .4 All burners shall include an ignition control, roll out switch and air proving switch. Additionally, on full modulation models a fan relay, delay timer and high fire gas valve control relay shall be included. Burners shall accept either 0 to 10vDC or 4 to 20ma input signals (signal provided by others). Two independent and adjustable (when compared to the analog input signal) SPDT relays shall be provided for fan and valve control.

2.10 UNIT ELECTRICAL

- .1 Provide factory mounted and wired VFDs for each fan motor. Each VFD shall have a by-pass.
- .2 Fan arrays shall be wired to a single source motor control panel with short circuit protection and non fused disconnect factory wired from the panel to the motors. Refer to spec section 20 05 30 for variable speed drive details.
- .3 Unit manufacturer shall provide wiring from each fan motor to a non fused disconnect type disconnect switch. Disconnect switch shall be furnished with a rotary or switch-blade type handle that can be padlocked in the OFF position.
- .4 Supply a factory installed hand-off-auto switch
- .5 Provide lights in all access sections. Lights shall be wired to an ON-OFF switch mounted on the outside of the cabinet. Interconnecting wiring between split sections shall be field supplied and installed.

3. EXECUTION

3.1 INSTALLATION OF SEMI-CUSTOM INDOOR AIR HANDLING UNITS

- .1 Provide semi-custom indoor air handling units.

- .2 Provide required rigging and hoisting/moving equipment required to move units to required locations. Perform rigging/hoisting/moving in accordance with unit manufacturer's directions and details.
- .3 Site assemble units shipped in sections in strict accordance with unit manufacturer's instructions.
- .4 Secure base mounting units in place, level, and plumb, on a concrete pad.
- .5 Remove fan base hold-down clamps and other shipping restraints and protective packaging.
- .6 Carefully coordinate the installation of each unit with other trades making connections to unit, in particular, control connections.
- .7 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .8 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements. Submit a copy of the letter prior to Substantial Performance.
- .9 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, with abnormal events.

END OF SECTION

1. GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings/product data sheets for all make-up air units. Include following:
 - .1 certified fan performance curves;
 - .2 certified sound power data;
 - .3 computer generated psychrometric chart for each cooling coil;
 - .4 hardware for section-to-section site connections;
 - .5 dimensioned layouts, including dimensioned curb layouts as applicable;
 - .6 product data for fan motors.
- .2 Submit with delivery of each unit a copy of the factory inspection and fire test report as specified in Part 2 of this Section, and include a copy of each report with O & M Manual project close-out data.
- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .4 Submit spare air filters as specified in Part 2 of this Section.

1.2 QUALITY ASSURANCE

- .1 Make-up air units and installation are to be in accordance with requirements of the following:
 - .1 all applicable Provincial Codes and Standards;
 - .2 CAN/CSA B149, Natural Gas and Propane Installation Codes;
 - .3 CSA or ETL listed and labelled electrical components.
- .2 Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- .3 Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- .4 Unit shall be certified by ETL and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label. The nameplate, safety labels and warnings will be in English and French.
- .5 Unit installation tradesmen are to be journeyman and licensed gas fitters.

1.3 WARRANTY

- .1 The warranty period shall commence at the date of initial start up and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include parts only.
- .2 Manufacturer shall furnish a factory trained service technician to perform the unit start-up assistance to the installing contractor with licensed gas personnel. Factory technician to provide copy of start-up log to owner and to demonstrate operation and maintenance to owner's representative.

2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- .1 Acceptable manufacturers of Semi-Custom Rooftop Units are:
 - .1 Daikin – Rebel Applied;
 - .2 AAON.

2.2 GENERAL DESCRIPTION

- .1 Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with refrigerant and oil.
- .2 The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
- .3 All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door.
- .4 Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
- .5 Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values.
- .6 All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

2.3 CASING

- .1 Panel construction shall be double-wall thermally broken construction for all panels. 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. Insulation shall be a minimum of 2" thick with an R-value of 13.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 8.0 inches w.g.
- .2 Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 1000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
- .3 Service doors shall be provided on 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.
- .4 The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.4 FILTERS

- .1 The filter section shall be provided with a 2 inch MERV-8 prefilter and a 12" inch cartridge

MERV-14 final filter.

2.5 OUTDOOR / RETURN AIR SECTION

- 2.6 Unit shall be provided with a 100% outdoor air hood. The 100% outdoor air hood shall allow outdoor air to enter from the back of the unit, at the draw-through filter section. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream.

2.7 SUPPLY FAN

- .1 Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- .2 All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
- .3 Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.
- .4 The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- .5 The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.8 EXHAUST FAN

- .1 Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- .2 The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- .3 The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

2.9 COOLING COIL

- .1 The indoor coil section shall be installed in a draw through configuration, upstream of the

supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.

- .2 The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
- .3 The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
- .4 The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
- .5 The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

2.10 CONDENSING SECTION

- .1 Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high- pressure air under water.
- .2 Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0-120°F. Mechanical cooling shall be provided to 0° F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
- .3 The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material
- .4 The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and low oil safety protection.
- .5 Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
- .6 Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

2.11 GAS HEATING SECTION

- .1 The rooftop unit shall include a natural gas heating section. The gas furnace design shall be

one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.

- .2 Each module shall have 5:1 modulating heating control.
- .3 The heat exchanger tubes shall be constructed of stainless steel.
- .4 The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
- .5 Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.
- .6 The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the gas heating modules.

2.12 HEAT PUMP HEATING

- .1 The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heatpump operation. The refrigerant circuit shall contain a 4 way reversing valve for the heatpump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
- .2 The refrigerant system shall have a pump-down cycle.

2.13 ENERGY RECOVERY

- .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 does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.
- .2 The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers For Energy Recovery Ventilation Equipment.
- .3 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.
- .4 The unit shall have 2" Merv 7 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.
- .5 The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.

- .6 The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- .7 Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.
- .8 Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.
- .9 The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.
- .10 The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall slow down the wheel. When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.
- .11 Heat wheel shall include a VFD controlled by unit microprocessor for modulating the rotational speed as required to limit leaving air temperature off the wheel to a field adjustable setpoint. Wheel VFD shall be factory installed and tested.

2.14 ELECTRICAL

- .1 Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with 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.
- .2 A terminal block shall be provided for the main power connection and a terminal board shall be provided for the low voltage control wiring. Knockouts shall be provided in the bottom of the main control panel for field wiring entrance. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit.
- .3 Each compressor and condenser fan motor shall be furnished with contactors and internal thermal overload protection. Supply fan motors shall be supplied with external overload protection.
- .4 Unit shall include a 115V receptacle to be field wired and powered by separate connection.
- .5 Provide a disconnect switch to cut power to the entire unit before the control panel can be opened.

2.15 CONTROLS FOR APPLIED ROOFTOP

- .1 Each unit shall be equipped with a Daikin MicroTech® III microprocessor based control 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 The DDC control system shall permit starting and stopping of the unit locally or remotely. A set of contacts shall be provided for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- .3 The unit control system shall have the ability to communicate with an independent Building Management System (BMS) via a direct (BACnet Ethernet) (BACnet MSTP) communication connection. The independent BMS system shall have access to "read only" variables and "read & and write" variables. Communications shall not require field mounting of any additional sensors or devices at the unit. The BMS system shall be capable of interacting with the individual rooftop controllers in the following ways:
 - .1 Monitor controller inputs, outputs, set points, parameters and alarms
 - .2 Set controller set points and parameters
 - .3 Clear alarms
 - .4 Reset the cooling and heating discharge air temperature set point
 - .5 Set the heat/cool changeover temperature
 - .6 Set the representative zone temperature
- .4 It will be the responsibility of the Systems Integrating Contractor to integrate the rooftop data into the BMS control logic and interface stations.
- .5 The controller shall have a 4 line x 20 character display with all information and instructions shown in plain English. A keypad shall allow information and controls to be accessed. The microprocessor shall have a programmable time clock, store current and past alarm conditions.
 - .1 The display shall provide the following information:
 - .2 Unit status including # of stages or % capacity for fans, heating, cooling and economizer.
 - .3 Supply, return, outdoor, and space air temperature
 - .4 Duct and building static pressure; the control contractor is responsible for providing and installing sensing tubes
 - .5 Outside air damper position and economizer mode
 - .6 Cooling and heating changeover status
 - .7 Occupied, unoccupied, and dirty filter status
 - .8 Date and time schedules
 - .9 Alarm faults
- .6 The following set points shall be adjustable:

- .1 Control mode (Off / Auto / Cool Only / Fan Only / Heat Only)
 - .2 Occupancy mode (Auto / Tenant Override / Occupied / Unoccupied)
 - .3 Changeover mode (return air, space temperature or network signal)
 - .4 Cooling and heating discharge air temperature control
 - .5 Compressor lockouts and timers
 - .6 Economizer changeover (enthalpy or dry bulb)
 - .7 Scheduling
 - .8 Building static pressure control
- .7 When heat recovery units are specified, the control of the energy recovery wheel shall form an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed on the rooftop units LCD display. All of these temperatures shall be made available through the BACnet interface.
- .8 The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure set point.
- .9 Supply air reset options shall include; return air temperature, outdoor air temperature, space temperature, airflow (VAV), network signal, external signal (1-5 vdc or 0-20 mA)
- .10 The controller shall be complete with night setback control. The controller shall use its internal time clock for scheduling and have an adjustable override timer. (The unit shall be supplied with a wall mounted space sensor with an override button for field installation).

2.16 REFRIGERATION ONLY CONTROLS

- .1 Provide a microprocessor based system to control all refrigeration functions including compressor speed, condenser fan function, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall operate the unit at peak efficiency utilizing variable head pressure control and electronic expansion valve while maintaining the cooling, or heating in heat pump operation, call per third party control. The microprocessor control shall consist of only direct expansion required temperature sensors, pressure sensors, controller and keypad/display operator interface. Refrigeration sensors and controller shall be factory mounted, wired and tested.
- .2 The microprocessor controls shall be solely dependent on communications with a 3rd party DDC rooftop controller supplied by the BAS contractor for proper unit operation. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. No commissioning settings shall be lost, even during extended power shutdowns
- .3 The microprocessor controls shall be dependent on starting and stopping and modulation of the unit via terminal strip control and logic. The control system shall be capable of providing a remote alarm indication. The microprocessor shall provide compressor capacity & status, defrost status (heat pump only), condensate overflow alarm, and dirty filter alarm.
- .4 All digital and analog 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

- .5 The keypad interface shall allow convenient navigation and access to the commissioning functions. The 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 Supply and exhaust fan speed control limits.
 - .2 Refrigeration alarm details.
- .6 Daikin will provide the following terminals for remote control by 3rd party DDC controller (BAS supplied):

.1 Compressor capacity command/status	(Ao/Ai)
.2 Compressor capacity status	(Bi)
.3 Supply fan S/S	(Bo)
.4 Supply fan capacity	(Ao)
.5 Exhaust fan S/S	(Bo)
.6 Exhaust fan capacity	(Ao)
.7 Outdoor air damper	(Ao)
.8 Mode select (heat/cool)	(Bo)
.9 Heating Modulation/Enable	(Ao/Bo)
.10 Heat S/S	(Bo)
.11 Defrost Status (Heat Pump Only)	(Bi)
.12 Alarm Status	(Bi)
.13 Alarm Reset (120V)	(Bo)
.14 Hot Gas Reheat Capacity	(Ao)
.15 Airflow Measuring Station	(Ai)
.16 Outdoor Enthalpy Sensor	(Bi)
.17 Dirty Filter	(Bi)
.18 Energy Recovery Wheel S/S	(Bo)
.19 Energy Recovery Wheel Speed	(Ao)
.20 ERW Bypass Damper Position	(Bo)
- .7 BAS contractor shall be responsible for supply and install of the following loose sensors as required to meet the specified sequences:

- .1 Discharge air temperature
- .2 Outdoor air temperature/humidity
- .3 Return air temperature
- .4 Entering/Leaving wheel temperature
- .5 Duct static pressure
- .6 Space temperature/humidity
- .7 Space/building pressure
- .8 Duct high limit
- .9 CO2 measuring
- .10 Airflow proving
- .11 Condensate overflow

2.17 ROOF CURB

- .1 A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. 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 (18") high and include a nominal 2"x4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb. The roof curb shall be approved by the National Roofing Contractors Association.

2.18 STARTUP SERVICE

- .1 Manufacturer shall furnish a factory trained service technician to perform the unit startup. Manufacturer shall provide instruction to the owner's personnel on the operation and maintenance of the unit. Factory technician to provide copy of start up log to owner and to demonstrate operation and maintenance to owners' representative.

3. EXECUTION

3.1 INSTALLATION OF SEMI-CUSTOM ROOFTOP UNITS

- .1 Provide Semi-Custom Rooftop Units.
- .2 Provide required rigging and hoisting/moving equipment required to move each unit to required locations. Perform rigging/hoisting/moving in accordance with unit manufacturer's directions and details.
- .3 Hand a curb for each roof mounted unit to roofing trade on roof for installation and flashing into roof construction. Secure each unit in place on roof curb. Provide continuous gasketing around perimeter of each curb between curb and unit mounting frame.
- .4 Install components shipped loose with units. Install in accordance with manufacturer's recommendations. Calibrate control components requiring field calibration.
- .5 Extend condensate trapped drains using Schedule 40 galvanized steel piping to roof.

- .6 Provide remote control panels. Confirm exact locations prior to roughing-in. Connect complete with 24 volt control wiring in conduit to standards of electrical work and in accordance with manufacturer's certified wiring diagram.
- .7 Carefully coordinate installation of each unit with all other trades making connections to unit, in particular, power, interlock connections, and control connections.
- .8 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .9 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .10 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, with abnormal events.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 Submit shop drawings/product data sheets, complete with control components, and piping and wiring schematics.
- .2 Submit a start-up and certification letter from equipment supplier as specified in Part 3 of this Section.
- .3 Submittals shall include the following: performance and capacity details of all units at specified indoor and outdoor conditions, piping schematics outputted from manufacturer specific software including pipe sizes and estimated piping lengths, refrigerant charge per system including CSA B52 analysis, wiring diagrams, and 10 year parts only warranty information.
- .4 Submittal shall include a copy of the installing contractor's certification of VRF manufacturer approved training.

1.02 QUALITY ASSURANCE

- .1 Split system air conditioning equipment and installation of equipment are to be in accordance with requirements of following:
 - .1 all applicable Provincial Codes and Standards;
 - .2 ANSI/AHRI Standard 210/240, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- .2 Split system air conditioning system installation tradesmen are to be journeyman refrigeration mechanics.

2 PRODUCTS

2.01 GENERAL

- .1 This section includes the design, performance, refrigerant details, controls and installation requirements for Variable Refrigerant Flow Systems
- .2 All units shall be listed and rated by ANSI/AHRI Standard 1230-2010 and meet all minimum IEER performance requirements as scheduled.
- .3 The units shall be CSA approved, ANSI/UL STD 1995 listed and listed by Electrical Testing Labs (ETL) and bear the cETL label.
- .4 All wiring shall be in accordance with the National Electric Code (NEC).
- .5 The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- .6 The system and the design shall be in compliance with CSA B52 Mechanical Refrigerant Code.

2.02 ACCEPTABLE MANUFACTURERS ARE:

- .1 Mitsubishi Electric Sales Canada Inc.;
- .2 Daikin Industries Ltd;
- .3 Samsung;
- .4 LG.

2.03 SYSTEM DESCRIPTION

- .1 Per the equipment schedule, the variable capacity, heat pump heat recovery air conditioning system shall be a Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system (or approved equal).
- .2 The Y-Series system shall consist of a PUMY outdoor unit, and M-NET DDC (Direct Digital Controls). Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. To ensure owner comfort, each indoor unit or group of indoor units shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8 degrees F from set point for ten minutes. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor rated capacity.

2.04 START-UP AND WARRANTY

- .1 The units shall be covered by the manufacturer's limited warranty for a period of one (1) year from date of commissioning.
- .2 If the systems composing the units are:
 - .1 Installed by a contractor that has successfully met the manufacturer's requirements for service training; AND
 - .2 Verified with a completed commissioning report submitted to and approved by the manufacturer,
- .3 then the units shall be covered by an extended manufacturer's limited warranty for a period of five (5) years from date of commissioning.
- .4 In addition, the compressor(s) of the units shall have a manufacturer's limited warranty for a period of seven (7) years from date of commissioning.
- .5 If, during the above period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.
- .6 This warranty shall not include labour.
- .7 Installing contractor shall meet the manufacturer's requirements to obtain an extended manufacturer's limited parts and compressor warranty for a period of ten (10) years to the original owner from date of commissioning. This extended warranty shall not include labour.

- .8 All manufacturer technical and service manuals shall be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.
- .9 The VRF system shall be installed by a contractor with extensive install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

2.05 OUTDOOR HEAT PUMP UNIT

- .1 The outdoor unit modules shall be air-cooled, direct expansion (DX), multi-zone units used specifically with VRF components described in this section and Controls Session. The outdoor unit modules shall be equipped with a single compressor which is inverter-driven and multiple circuit boards—all of which must be manufactured by the branded VRF manufacturer. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
- .2 Outdoor unit shall have a sound rating no higher than 65 dB(A) individually or 70 dB(A) twinned. Units shall have night mode operation. Units shall have 5 levels sound adjustment via dip switch selectable fan speed settings. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
- .3 Both refrigerant lines from the outdoor unit to the indoor unit(s) shall be insulated in accordance with the installation manual.
- .4 The outdoor unit shall have an accumulator with refrigerant level sensors and controls. Units shall actively control liquid level in the accumulator via Linear Expansion Valves (LEV) from the heat exchanger.
- .5 Outdoor unit shall be able to connect to up to 50 indoor units depending upon model and configuration.
- .6 The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
- .7 The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
- .8 The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet. The greatest length is not to exceed 541 feet between outdoor unit and the indoor units without the need for line size changes or traps.
- .9 The outdoor unit shall be capable of operating in heating mode down to -13F ambient temperatures or cooling mode down to 23F ambient temperatures, without additional low ambient controls. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.
- .10 Manufacturer supplied low ambient kit shall be provided with predesigned control box rated for outdoor installation and capable of controlling kit operation automatically in all outdoor unit operation modes.

- .11 Manufacturer supplied low ambient kit shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
- .12 Manufacturer supplied low ambient kit shall be factory tested in low ambient temperature chamber to ensure operation. Factory performance testing data shall be available when requested.
- .13 The outdoor unit shall be provided with a manufacturer supplied snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.
- .14 The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.
- .15 Unit must defrost all circuits simultaneously in order to resume full heating more quickly during extreme low ambient temperatures (below 23F). Partial defrost, also known as hot gas defrost which allows reduced heating output during defrost, is permissible only when ambient temperature is above 23F.
- .16 Unit Cabinet:
 - .1 The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
 - .2 Outdoor unit components shall be coated with the Seacoast Protection Coating (Brine Spray – BS coating) to protect components from premature corrosion due to a seacoast environment. Coating shall be applied to components before original outdoor unit assembly to ensure manufacturer quality standards are not compromised and shall meet the following minimum requirements:
 - .1 $\geq 85\mu\text{m}$ thermoset polyester-resin powder coating on External Front Panel
 - .2 $\geq 70\mu\text{m}$ thermoset polyester-resin powder coating on External Panel Base, Pillar, Compressor Cover, Fan Motor Support, Electrical Box
 - .3 $\geq 1\mu\text{m}$ cellulose and polyurethane-resin coating on heat exchanger fins
 - .4 $\geq 10\mu\text{m}$ polyurethane coating on printed circuit boards
 - .3 The outdoor unit shall be tested in compliance with ISO9277 such that no unusual rust shall develop after 960 hours of salt spray testing.
 - .4 Panels on the outdoor unit shall be scratch free at system startup. If a scratch occurs the salt spray protection is compromised and the panel should be replaced immediately

.17 Fan:

- .1 Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.32 in. WG external static pressure via dipswitch.
- .2 All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
- .3 All fan motors shall be mounted for quiet operation.
- .4 All fans shall be provided with a raised guard to prevent contact with moving parts.
- .5 The outdoor unit shall have vertical discharge airflow.

.18 Refrigerant

- .1 R410A refrigerant shall be required for systems.
- .2 Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
- .3 Refrigerant line sizing shall be in accordance with manufacturer specifications. Future changes to indoor unit styles or sizes must be possible without resizing/replacing refrigerant piping to any other branch devices or indoor units.
- .4 All refrigerant piping must be insulated with ½" closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.
- .5 Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the VRF equipment manufacturer and installed in accordance with manufacturer recommendations.

.19 Coil:

- .1 Outdoor Coil shall be constructed to provide equal airflow to all coil face surface area by means of a 4-sided coil.
- .2 The coil fins shall have a factory applied corrosion resistant blue-fin finish.
- .3 The coil shall be protected with an integral metal guard.
- .4 Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
- .5 The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.
- .6 The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.

- .7 Condenser coil shall have active hot gas circuit direct from compressor discharge on lowest coil face area to shed defrost condensate away from coil and protect from ice formation after returning to standard heat pump operation. While in Heat Pump operation this lower section of the Outdoor Evaporator coil shall continually run hot gas from the compressor discharge to protect the coil from ice buildup and coil rupture. Manufacturers who do not have an active hot gas circuit in the lower section of the Outdoor coil to protect coil from freezing shall not be allowed in markets where the outdoor unit will see temperatures below freezing.
- .8 Unit shall have prewired plugs for optional panel heaters.
- .20 Compressor:
 - .1 Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.
 - .2 Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting "belly-band" type crankcase heaters are not allowed. Manufacturer's that utilize belly-band crankcase heaters will be considered as alternate only.
 - .3 The outdoor unit compressor shall have an inverter to modulate capacity. The operating range shall be completely variable with range down to 15% depending upon unit capacity, operation, and configuration.
 - .4 The compressor will be equipped with an internal thermal overload.
 - .5 Manufacturers that utilize a compressor sump oil sensor to equalize compressor oil volume within a single module shall not be allowed unless they actively shut down the system to protect from compressor failure.
 - .6 Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
- .21 Controls:
 - .1 Outdoor unit shall include Variable Evaporator Temperature or comparable method of varying system evaporator (refrigerant) temperature in order to reduce compression ratio and power consumption during light load or mild ambient temperatures. Multiple evaporator refrigerant temperature settings shall be required in order to optimize efficiency within required system-specific performance and installation constraints. System shall reduce compression ratio only when/if all indoor units are within 1.8F of setpoint; reducing compression ratio based solely on ambient temperature risks discomfort and is not allowed. Variable Evaporator Temperature or comparable method shall incorporate override or disable capability based on external signal to allow for space humidity control or load demand.
 - .2 The unit shall be an integral part of the system & control network described in section under Control and react to heating/cooling demand as communicated from connected indoor units over the control circuit. Required field-installed control voltage transformers and/or signal boosters shall be provided by the manufacturer.

- .3 Each outdoor unit module shall have the capability of multi levels of demand control based on external input.
- .22 Electrical:
 - .1 The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz.
 - .2 The outdoor unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz), 207-253V (230V/60Hz).
 - .3 The outdoor unit shall be controlled by integral microprocessors.
 - .4 The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.06 CONCEALED CEILING DUCTED UNIT

- .1 Indoor unit shall be a built-in ceiling concealed fan coil unit with variable speed direct drive DC type fan and auto CFM adjustment at commissioning. Casing shall be constructed of galvanized steel. Configuration shall be horizontal discharge air with horizontal return air, with a maximum height of 9-5/8" and be designed to fit in tight ceiling plenums.
- .2 The indoor unit's sound pressure shall range from 28 dB(A) to 36 dB(A) at low speed measured 5 feet below the ducted unit.
- .3 The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump shall provide up to 25" of lift from the center of the drain outlet and have a built-in safety shutoff and alarm.
- .4 The fan shall have a variable speed direct drive DC motor with statically and dynamically balanced impeller with 3 user-selectable fan speeds. The automatic fan speed mode shall allow the fan to vary between 5 speeds based on space load. The unit shall have logic for automatically adjusting external static pressure settings of the fan motor (selectable during commissioning).
- .5 The unit shall ship from the factory in a rear return configuration and shall be field convertible to a bottom return configuration.
- .6 Field installed MERV8 filters and filter kits with 2" or 4" filter depths.
- .7 Electrical:
 - .1 The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
 - .2 The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
- .8 Controls:
 - .1 The unit shall include an IR receiver for wireless remote control flexibility

- .2 Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
- .3 Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
- .4 Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
- .5 Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.07 LOCAL CONTROLS

- .1 The CMCN shall be capable of supporting integration with Building Management Systems (BMS).
- .2 The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. A web controller with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
- .3 System controls and control components shall be installed in accordance with the manufacturer's written installation instructions.
- .4 Furnish energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.
- .5 System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.
- .6 Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control.
- .7 System shall be capable of email generation for remote alarm annunciation.

2.08 BACNET MS/TP DEVICES

- .1 Provide VRF system with the ability to connect to the building BMS with BACnet Application Specific Controller (B-ASC) via BACnet IP or MS/TP.
- .2 B-ASC device shall enable a direct connection to a BACnet IP or MS/TP master device (SCADA, PLC, DDC or equivalent) via an CAT6 or EIA485 network.
- .3 B-ASC shall be wired and installed by the BMS contractor. B-ASC shall not require external power.
- .4 VRF manufacturer shall commission the BACnet devices. BMS contractor shall provide VRF manufacturer with the address points for commissioning.

- .5 All programming for monitoring and control of VRF system via the BACnet IP or MS/TP devices shall be by BMS contractor, as per the Sequence of Operation.

2.09 ELECTRICAL

- .1 Independent electrical power for fan coils shall be 208/230 volts, 1 phase, 60 hertz. The unit shall be capable of operating within the limits of 187 volts to 253 volts.
- .2 Unless limited by local electrical codes and standards, multiple fan coils can be connected to the same breaker. Field provided individual disconnect switches for each fan coil are required.
- .3 Electrical power for condensing units shall be 208/230 volts, 1 phase, 60 hertz. The unit shall be capable of operating within the limits of 187 volts to 253 volts.
- .4 The control voltage between the indoor and outdoor unit shall be 16VDC. The control wiring shall be communication type stranded non-shielded 18-2 AWG.
- .5 Control wiring shall be installed in a daisy chain configuration between all VRF components as per Manufacturer.

3 EXECUTION

3.01 INSTALLATION OF VARIABLE REFRIGERANT FLOW HVAC EQUIPMENT

- .1 Provide variable refrigerant flow HVAC equipment.
- .2 Install condensing units on a flat surface level within 1/8 inch, and elevated a minimum of 18" from ground or roof surface. Provide intermediate supports as recommended by the equipment manufacturer.
- .3 Provide all necessary control wiring as recommended by the manufacturer.
- .4 High/low pressure gas line, liquid, and suction lines must be individually insulated between the outdoor and indoor units.
- .5 Contact manufacturer prior to installation to review and confirm piping layout and lengths.
- .6 Use refrigeration best practice to allow pipes to expand and contract freely. Review manufacturer installation instructions to ensure expansion joints are properly designed.
- .7 Pressure test ALL systems to 550 PSI after system was vacuumed and held to below 500 microns for at least one hour. Review manufacturer installation instructions for proper pressure test procedures.
- .8 Design and install all piping as per TSSA and CSA B52 regulations, and apply and obtain TSSA certification for all systems.
- .9 Control system start-up shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained controls system configuration and operation. The representative shall provide proof of certification indicating successful completion of no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals. This service shall be equipment and system count dependent and shall be a minimum of one (1) eight (8) hour period to be completed during normal working hours.

END OF SECTION

1 GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings/product data sheets for radiation units, including accessories, and any required control wiring schematics.
- .2 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

1.2 QUALITY ASSURANCE

- .1 Each Units shall be fully tested at the factory.
- .2 All aluminum components shall be certified to meet ASTM G53 UV-resistance
- .3 Surface temperature remains safe at all times based on DHSS DN 4 1992 regulation and subsequent revision.
- .4 All units shall be individually packaged and labeled for eased on site locating and installation

2 PRODUCTS

2.1 FIN-TUBE TYPE DIRECTION RADIATION

- .1 Hot water fin-tube type low water direct radiation units with capacities/lengths as indicated on the drawings. Heating capacities and element lengths indicated are based on 54.4°C (130°F) average entering water temperature at a velocity of 0.0762 m/s (0.25 ft/sec) with an 11.1°C (20°F) temperature drop through the element, and 18.3°C (65°F) entering air temperature.
- .2 Cabinets:
 - .1 The Cabinet shall be fabricated with 16 gauge electrolytic galvanized steel and will be coated epoxy polyester baked at 392°F. Available in two colours as standard White or grey metallic. Custom colours available upon request.
 - .2 The Top grille shall provide supply air and bottom shall provide return.
 - .3 The Cabinet front face shall be constructed of a single uniform piece seamless in construction.
 - .4 The Cabinet shall be fabricated with heat exchanger support bracket. Standard configuration will be center mounted.
 - .5 All Valve connections shall be made inside of the cabinet unless separate enclosures are supplied.
 - .6 The Cabinet shall be fabricated such that there are no exposed corners or gaps. All corners shall be joined to form one solid piece – gaps are not permitted.
 - .7 The unit shall come with locate and fasten support structure.
 - .8 The Cabinet shall be factory Parts Warranted for 10 Years

.3 Heat Exchanger:

- .1 The Heat exchanger shall be of copper and aluminum construction. Shall be composed of round, seamless circulation tubes pure red copper, and two brass collectors.
- .2 The Fins shall be connected to the heat exchanger by expansion method only.
- .3 The Heat exchanger shall be rated for 290PSI working pressure.
- .4 The Heat exchanger shall be easily removable from cabinet if required.
- .5 The Heat exchanger shall be coated with dirt repellent and dust proof lacquer in graphite grey with 70% gloss to match cabinet.
- .6 The Heat exchanger shall be made to accommodate Jaga's Dynamic Boost Effect fans to increase heating output of the exchanger if so chosen.
- .7 The Heat exchanger shall be capable of same end supply/return and opposite end supply/return.
- .8 The Heat exchanger shall have ASTM G53 certification.
- .9 Each individual heat exchanger shall have EN442 certification. Output Correction factors will not be considered equivalent to establish output capacities.
- .10 Each Heat exchanger shall be of ultra low thermal inertia in design.
- .11 Each Heat exchanger shall come with 1/8" air vents hole and 1/2" drain plug hole, 1/2" NPT hydronic connections. NPT to BSP adapters not accepted.
- .12 The Heat Exchanger fins shall be corrugated by design.
- .13 The Heat Exchanger shall be shipped with vacuum sealed protection.
- .14 The Heat Exchanger shall be factory Parts Warranted for 30 Years

.4 Acceptable manufacturers are:

- .1 Engineered Air;
- .2 Sigma Corporation;
- .3 Rosemex Inc.;
- .4 Slant/Fin Ltd.

2.2 LINEAR RADIANT CEILING PANELS

- .1 Continuous linear radiant ceiling panels sized and arranged as shown and scheduled on drawings, complete with:
 - .1 extruded aluminum panels with aluminum saddles to secure 12 mm (1/2") diameter type "L" copper piping, non-hardening heat conductive paste between piping and panels, and a white finish factory applied to face of each panel;

- .2 cross channel braces in quantities as recommended by panel manufacturer to suit panel length, and end and centre clips;
 - .3 all required type "L" copper piping return bends and connection fittings.
- .2 Acceptable manufacturers are:
 - .1 Adair Industries "Airtex";
 - .2 Rosemex Inc;
 - .3 Giacomini;
 - .4 TWA Panel Systems Inc.;
 - .5 Sigma Corp.
- 3 EXECUTION
- 3.1 INSTALLATION OF FIN-TUBE DIRECT RADIATION UNITS
 - .1 Provide fin-tube type direct radiation units.
 - .2 Secure enclosure brackets in place at maximum 900 mm (35") centres and install element supports or cradles. Slope elements to ensure proper water circulating and to eliminate air. Ensure enclosures are level and plumb. Provide required enclosure accessories.
 - .3 Connect elements with piping. Provide radiator type valves in piping at each element or group of series connected elements, shut-off type in supply piping, balancing type in return piping. Unless otherwise noted or specified, locate valves and accessories inside enclosures or behind trim, and ensure valves are accessible.
 - .4 Where 2 or more heating elements are connected in series, join elements with piping the full size of the element tubes or use piping sized to supply pipe size and connect elements with eccentric fittings.
 - .5 Equip each element or group of series connected elements with a manual air vent installed in an accessible location.
- 3.2 INSTALLATION OF RADIANT CEILING PANELS
 - .1 Provide linear radiant ceiling panels. Install cross channel braces, end and centre clips in accordance with panel manufacturer's details.
 - .2 Secure panels in place on T-bars and/or wall channel moulding provided as part of suspended ceiling system work, and provide ceiling hanger wire at 1.2 m (48") centres between structure and cross channel braces.
 - .3 Interconnect radiant panels by means of 12 mm dia. (1/2") soft copper tubing or connection accessories supplied with panels, as required. Ensure heating piping system has been flushed and cleaned prior to connecting radiant panels.
 - .4 Personnel handling unprotected panels are to wear clean white gloves to avoid soiling panel face finish.

- .5 When installation of the panels is complete, cover the top of active panels with 25 mm (1") thick glass fibre batt insulation.

END OF SECTION

1. GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings/product data sheets for motorized heaters, including accessories.
- .2 Submit a site start-up report from manufacturer's representative as specified in Part 3 of this Section.

2. PRODUCTS

2.1 UNIT HEATERS

- .1 CSA certified hot water unit heaters in accordance with drawing schedule, each complete with:
 - .1 for horizontal unit casing, minimum #20 gauge die-formed steel front and back casing halves with formed ribs and rounded corners, both halves secured together top and bottom with screws and equipped with threaded hanger rod connections in the top, a formed fan venturi with bolt-on wire grid guard in the back, and a rectangular formed discharge opening with adjustable horizontal and vertical air deflectors in the front;
 - .2 factory applied casing finish, consisting of electrostatically applied baked powder epoxy on cleaned and primed casing surfaces;
 - .3 factory leak tested heating coil, consisting of minimum 16 mm (5/8") OD seamless copper tubing mechanically expanded into and permanently bonded to continuous plate type aluminum fins, and equipped with screwed steel supply and return piping connections and silver braced tube joints;
 - .4 continuous duty TEFC motor conforming to requirements specified in Section entitled Basic Mechanical Materials and Methods, direct connected to a balanced propeller type fan wheel with aluminum blades secured to a steel hub;
- .2 Acceptable manufacturers are:
 - .1 Modine Manufacturing Co.;
 - .2 Rosemex Inc.;
 - .3 Armstrong-Hunt Inc.;
 - .4 McQuay International;
 - .5 Engineered Air.

3. EXECUTION

3.1 INSTALLATION OF MOTORIZED HEATERS

- .1 Provide motorized heaters.
- .2 Secure unit heaters in place at proper height by means of hanger rods attached to structure. Ensure heaters are level and plumb. Confirm exact locations prior to roughing-in.

- .3 Carefully coordinate installation of cabinet heaters with trades constructing building surfaces in or on which heaters are located. Confirm exact locations prior to roughing-in.
- .4 Connect with piping in accordance with drawing detail.
- .5 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .6 Include for a 4 hour on-site heater operation demonstration and training session. Training is to be a full review of all components including but not limited to construction details, operation, and maintenance.

END OF SECTION

1 GENERAL

1.01 ACCEPTABLE CONTROLS SUPPLIERS

- .1 Unless otherwise noted, the acceptable controls and instrumentation suppliers are as follows:

- .1 Reliable Controls Corporation (Setpoint Building Automation).

1.02 SUBMITTALS

- .1 Submit shop drawings/product data sheets for following:

- .1 all control system components;
 - .2 identified schematic control diagrams with component identification, catalogue numbers, and sequence of operation for all systems;
 - .3 certified wiring diagrams for all systems.

- .2 Submit following samples for review:

- .1 control damper section with linkage, operator, and certified flow and leakage data;
 - .2 wall mounting control system flow diagram as specified in Part 2 of this Section;
 - .3 each type of thermostat to be used, each identified as to intended use.

- .3 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

- .4 Submit written confirmation from control component manufacturer that site installation personnel are qualified and experienced in installation of components, and have parts and service availability on a 24/7 basis.

1.03 QUALITY ASSURANCE

- .1 Control systems are to be installed by control component manufacturer or by licensed personnel authorized by control component manufacturer. Submit written confirmation from control component manufacturer.
- .2 Control system installation company is to have local parts and service availability on a 24/7 basis.
- .3 Control wiring work is to be performed by licensed journeyman electricians, or under direct daily supervision of journeyman electricians.

2 PRODUCTS

2.01 CONTROL DAMPER AND ACTUATORS

- .1 Unless otherwise specified, control dampers are to conform to requirements specified in Section entitled HVAC Distribution.
- .2 Actuators to be 24V only and operate on a 0-10VDC or 2-10VDC signal.

- .3 Two-position (on/off) actuator are not acceptable.
- .4 Each actuator shall be "fail safe" and complete with external adjustable stops to limit the length of stroke in either direction. Operators shall be mounted on adjustable brackets. Operating arms shall have double yoke linkages and double set screws for fastening to the damper shaft. Damper operators shall be selected to operate maximum damper loads of 20 sq. ft. (1.9 sq.m). Where damper sizes exceed this area rating, multiple damper operators shall be provided.
- .5 Damper actuators shall be spring return to fail safe position.
- .6 Equip operators for dampers connected into the building fire alarm system or to freeze protection with additional relays to permit the dampers to respond and go to the required position in less than fifteen (15) seconds upon receipt of signal.
- .7 Damper actuators associated with air handling units shall operate on a 0-10 VDC signal only.
- .8 Damper actuators exposed to the exterior elements shall be provided with a Belimo ZS-100 Series Weather Shield, or equivalent, weatherproof enclosure.
- .9 Acceptable actuator manufacturers are Belimo and Siemens Building Technologies.

2.02 AUTOMATIC CONTROL VALVES AND OPERATORS

- .1 Each control valve must be suitable in all respects for the application, including system pressure, and must have design output and flow rates with pressure drops as follows:
 - .1 heating water valves for radiation units: maximum of 13.9 kPa (2 psi);
 - .2 heating water valves for heating coils: equal to the pressure drop of the coil to a maximum of 41.5 kPa (6 psi).
- .2 Actuators to be 24V only and operate on a 0-10VDC or 2-10VDC signal.
- .3 All valve actuators shall be spring return to fail safe position.
- .4 Unless otherwise indicated control valves shall be fully modulating type with equal percentage characteristics. Two-position (On/Off) control valves are not acceptable. All valves are to have position indicators. Valves for outdoor applications must be suitable in all respects for the application.
- .5 Automatic control valves for air handling systems and heat exchanger to be globe style valves.
- .6 Automatic 3-way control valves to be globe style valves.
- .7 Automatic 2-way control valves to be ball style valves.
- .8 Unless otherwise specified, control valves in hydronic piping systems are to conform to requirements specified in Section entitled Hydronic Piping Specialties and Pumps.

- .9 Each automatic control valve must provide the design output and flow rates at pressure drops compatible with equipment selected, must be suitable for the particular system working pressure, and shall be fitted with a position indicator and "fail-safe" operator capable of tight shut-off against the differentials imposed by the system.
- .10 Heating valves shall be normally open unless otherwise noted. Cooling valves shall be normally closed unless otherwise noted.
- .11 Butterfly type control valves with motorized gear operators will be acceptable where shown and/or specified on the drawings.
- .12 Electric valve operators are to be equal to Belimo "EF Series" enclosed reversible gear type operators that can accept modulating control signals as required. Each is to be 1-phase AC, 120 or 24 volt as required or indicated, overload protected, and complete with an enclosure to suit the mounting location.
- .13 Acceptable valve manufacturers are Belimo and Siemens Building Technologies.

2.03 FIELD DEVICES

- .1 Components specified below are required for control of equipment and systems in accordance with drawing control diagrams and sequences of operation. Not all required components may be specified.
- .2 Sensor/transmitter input devices must be suitable in all respects for the application and mounting location. Devices are as follows:
 - .1 unless otherwise specified, temperature sensors are to be resistance type, either 2-wire 1000 ohm nickel RTD or 2-wire 1000 ohm platinum RTD with accuracy (includes errors associated with sensor, lead wire, and A to D conversion), equipped with type 316 stainless steel thermowells for pipe mounting applications, as follows:
 - .1 chilled water, room temperature, and duct temperature points, $\pm 1^{\circ}\text{C}$ ($\pm 0.5^{\circ}\text{F}$);
 - .2 all other points, $\pm 0.75^{\circ}\text{C}$ ($\pm 1.3^{\circ}\text{F}$).
 - .2 room temperature sensors constructed for surface or recessed wall box mounting, complete with an adjustable set-point reset slide switch with a $\pm 1.66^{\circ}\text{C}$ ($\pm 3^{\circ}\text{F}$) range, individual heating/cooling set-point slide switches as required, a momentary override request pushbutton for activation of after-hours operation, an analogue thermometer;
 - .3 outside air sensors designed and constructed for ambient temperatures and to withstand environmental conditions to which they are exposed, complete with a NEMA 3R enclosure, solar shield, and a perforated plate surrounding sensor element where exposed to wind velocity pressure;
 - .4 insertion duct mounting sensors type with lock nut and mounting plate, designed to mount in an electrical box (weather-proof with gasket and cover where outside) through a hole in duct;
 - .5 for ducts greater than 1.2 m (4') or for ducts where air temperature stratification occurs, averaging type sensors with multiple sensing points, and for plenums for applications such as mixed air temperature measurement to account for air turbulence and/or stratification, an averaging string of sensors with capillary supports on the sides of duct/plenum;

- .6 factory solid-state relative humidity sensors with an element that resists contamination, weather-proof with a NEMA 3R enclosure for outside air applications, supplied with a type 304 stainless steel probe with mounting bracket and hardware for duct mounting, each complete with a factory calibrated humidity transmitter which is accurate (including lead loss and analog to digital conversion) to 3% between 20% to 80% RH at 25°C (77°F) and equipped with non-interactive span and zero adjustments, and a 2-wire isolated loop powered, 4-20 mA, 0 to 100% linear proportional output;
- .7 carbon dioxide sensors for air quality control purposes having a maximum 20 second response time, suitable for operating conditions from 0°C to 50°C (32°F to 122°F) and 0 to 100% RH non-condensing, complete with a calibration kit (to be handed to Owner) and characteristics as follows:
 - .1 measurement range: 0 to 2000 ppm;
 - .2 accuracy: ± 100 ppm;
 - .3 repeatability: ± 20 ppm;
 - .4 drift: ± 100 ppm per year;
 - .5 output signal: 0 to 10 VDC proportional over the 0 to 2000 ppm range.
- .3 Pressure transmitters are to be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input. Pressure transmitters are to transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal. Differential pressure transmitters used for flow measurement are to be sized to the flow sensing device and supplied with a tee fitting and shut-off valves in the high and low sensing pick-up lines to allow permanent ease of use connection for balancing, etc. Transmitter housing is to suit mounting location. Standalone pressure transmitters are to be mounted in a minimum NEMA 1 (NEMA 2 in sprinklered area) by-pass valve assembly panel with high and low connections piped and valved, air bleed units, by-pass valves, and compression fittings. Transmitters are to be as follows:
 - .1 low differential water pressure, 0 to 5 kPa (0 to 20" wc): equal to Setra or Mamac industrial quality transmitter capable of transmitting a linear 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
 - .1 maintain accuracy up to 20 to 1 ratio turndown;
 - .2 reference accuracy: $\pm 0.2\%$ of full scale.
 - .2 medium to high differential water pressure, over 5 kPa (20" wc): equal to Setra or Mamac transmitters as specified above for low pressure transmitters but with a pressure range of from 2.5 kPa (10" wc) to 2070 kPa (300 psi), a reference accuracy of $\pm 1\%$ of full span (includes non-linearity, hysteresis, and repeatability);
 - .3 building differential air pressure: equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:

- .1 maintain accuracy up to 20 to 1 ratio turndown;
 - .2 reference accuracy: +0.2% of full span.
- .4 low differential air pressure, 0 to 1.25 kPa (0" to 5" wc): equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
- .1 maintain accuracy up to 20 to 1 ratio turndown;
 - .2 reference accuracy: +0.2% of full span.
- .5 medium differential air pressure, over 1.5 kPa (5" wc): equal to Setra or Johnson Controls Inc. transmitters as specified above for low pressure air transmitters but performance requirements as follows:
- .1 zero and span: (c/o F.S./Deg. F); .04% including linearity, hysteresis, and repeatability;
 - .2 accuracy: 1% F.S. (best straight line); static pressure effect: 0.5% F. S.;
 - .3 thermal effects: <+0.33 F.S./°F over 40°F to 100°F (calibrated at 70°F).
- .4 Air and water flow monitoring stations and probes are to be Air Monitor Corp., Tek-Air Systems Inc., Ebtron, or Dietrich Standard products as follows:
- .1 Fan Inlet Air Flow Measuring Station: At fan inlet and near exit of inlet sound trap, air flow traverse probes are to continuously monitor fan air volume and system velocity pressure, and traverse probes are to be as follows:
 - .1 each probe is to be of a dual manifold, cylindrical, anodized type 3003 extruded aluminium construction probe with sensors located along the stagnation plane of approaching air flow, and the static pressure manifold is to incorporate dual offset static taps on opposing sides of averaging manifold so as to be insensitive to flow angle variations for as much as $\pm 20^\circ$ in approaching air stream;
 - .2 each probe is not to introduce a measurable pressure drop, nor is sound level within duct to be amplified by its singular or multiple presence in air stream, and each probe is to contain multiple static and total pressure sensors placed at equal distances along its length in accordance with ASHRAE Standards for duct traversing.
 - .2 Single Probe Air Flow Measuring Sensor: Duct mounting hot wire anemometer type which utilizes 2 temperature sensors, one is a heater element temperature sensor and the other is to measure downstream temperature, with temperature differential related directly to air flow velocity. Sensor insertion length is to be adjustable up to 200 mm (8"), and transmitter is to produce a 4 to 20 mA or 0 to 10 VDC signal linear to air velocity.

- .3 Duct Flow Measuring Stations: #14 gauge galvanized steel casing with duct connection flanges of a size to mate with connecting ductwork, and complete with an air directionalizer and a 98% free area parallel cell 20 mm ($\frac{3}{4}$ ") honeycomb profile suppressor across entering air stream to equalize velocity profile and eliminate turbulent and rotational flow from the air stream prior to measuring point, mechanically fastened to casing so as to withstand velocities of up to 1828 m (6000') per minute. Additional requirements as follows:
 - .1 total pressure measurement side (high side) is to be designed and spaced to requirements of Industrial Ventilation Manual, 16th Edition, page 9-5, and self-averaging manifolding is to be constructed of brass and copper components;
 - .2 static pressure sensing probes (low side) is to be bullet-nose shaped, per detailed radius, as illustrated in Industrial Ventilation Manual referred to above, page 9-5;
 - .3 main take-off point from both total pressure and static pressure manifolds is to be symmetrical, and manifolds are to terminate with external ports for connection to control tubing;
 - .4 each station is to be equipped with a label on casing indicating unit model number, size, area, and specified air flow capacity;
 - .5 each station is to have a self-generated sound rating of less than NC 40, and sound level within duct is not to be amplified nor is additional sound to be generated.
- .4 Static Pressure Traverse Probe: Duct mounting, complete with multiple static pressure sensors located along exterior surface of cylindrical probe.
- .5 Shielded Static Air Probe: Indoor type or outdoor type as required, each with multiple sensing ports, an impulse suppression chamber, and air flow shielding.
- .6 Water Flow Monitoring: Equal to Onicon microprocessor-based electromagnetic water flow meters with an accuracy of 0.25%.
- .5 Power (amps) monitoring is to be performed by a combination of a current transformer and a current transducer with transformer sized to reduce full amperage of monitored circuit to a maximum 5 ampere signal which will be converted to a 4 to 20 mA DDC compatible circuit for use by building automation system. Current transformer and current transducer are as follows:
 - .1 equal to Veris Industries split core current transformer with an operating frequency of from 50 to 400 Hz, 0.6 Kv class, 10 Kv BIL insulation, and 5 ampere secondary;
 - .2 equal to Veris Industries current to voltage or current to mA transducer with an accuracy of $\pm 5\%$, a minimum load resistance of 30 kOhm, an input of 0 to 20 amperes and an output of 4 to 20 mA, and a 24 VDC regulated power supply.
- .6 Duct mounting smoke detectors supplied as part of electrical work for mounting as part of control system work.
- .7 Double contact switches to monitor equipment status and safety conditions, and generate alarms when a failure or abnormal condition occurs. Status and safety switches are to be as follows:

- .1 current sensing switches: equal to Veris Industries self-powered dry contact output switches for sensing run status of motor loads, each calibrated to indicate a positive run status only when motor is operating under load, and each consisting of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid-state switch, SPDT relay, and a LED to indicate on or off status;
- .2 air filter status switches: equal to Johnson Controls Inc. or Cleveland Controls automatic reset type differential pressure switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC, a scale range and differential pressure adjustment appropriate for the service, and an installation kit which includes static pressure taps, tubing, fittings, and air filters;
- .3 air flow switches: equal to Johnson Controls Inc. or Cleveland Controls pressure flow switches, bellows actuated mercury switch or snap-acting micro-switch type with an appropriate scale range and pressure adjustment;
- .4 air pressure safety switches: equal to Johnson Controls Inc. or Cleveland Controls manual reset switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC and an appropriate scale range and pressure adjustment;
- .5 water flow switches: equal to Johnson Controls Inc. Model P74;
- .6 low temperature limit switches: manual reset type equal to Johnson Controls Inc. Model A70, each complete with DPST snap acting contacts rated for 16 amperes at 120 VAC, a minimum 4.5 m (15') sensing element for mounting horizontally across duct/plenum with sensing reaction from coldest 450 mm (18") section of element, and where sensing element does not provide full coverage of air stream, additional switches are to be supplied as required.
- .8 Control relays as follows:
 - .1 control pilot relays: equal to Johnson Controls Inc. or Lectro modular plug-in design with snap-mount mounting bases, retaining springs or clips, DPDT, 3 PDT or 4 PDT as required for the application, with contacts rated for 10 amperes at 120 VAC;
 - .2 lighting control relays: latching type with integral status contacts rated for 20 amperes at 120 VAC, each complete with a split low voltage coil that moves the voltage contact armature to On or Off latched position, each controlled by a pulsed tri-state output (preferred) or pulsed paired binary outputs, and each designed so power outages will not result in a change-of-state and so multiple same state commands will simply maintain commanded state.
- .9 Electronic signal isolation transducers equal to Advanced Control Technologies for installation whenever an analog output signal from building automation system is to be connected to an external control system as an input (i.e. equipment control panel), or is to receive as an input signal from a remote system, and to provide ground plane isolation between systems.
- .10 Each manual override station is to be complete with contacts rated minimum 1 ampere at 24 VAC and is to provide following:
 - .1 integral H-O-A switch to override controlled device pilot relay;
 - .2 status input to building automation system to indicate whenever switch is not in the Auto position;

- .3 status LED to illuminate whenever output is On;
- .4 override LED to illuminate whenever H-O-A switch is in either the Hand or Off position.
- .11 Electronic/pneumatic transducers equal to Johnson Controls Inc. transducers with an output of from 3 to 15 psig, an input of from 4 to 20 mA or 10 VDC, manual output adjustment, a pressure gauge, and an external replaceable supply air filter.
- .12 Thermostats:
 - .1 Wall mounting adjustable set-point thermostats, each suitable in all respects for equipment (and operating sequence) they are provided for, equipped with a thermometer, a cover and any required mounting and connection accessories.
 - .2 Line voltage thermostats are to be 115 volt.
 - .3 Low voltage thermostats are to be 24 volt electronic type.
 - .4 Set-point adjustment for thermostats in public spaces is to be concealed behind cover. Set-point adjustment for other thermostats is to be accessible through cover.
 - .5 Covers are to be removable, tamper-proof covers with temperature set-point and thermometer displays.
 - .6 Guards for thermostats are to be clear, ventilated polycarbonate covers with allen key locking hardware.
- .13 Humidistats:
 - .1 Direct or reverse acting (to suit system), proportional type, adjustable humidity controllers, each corrosion resistant, suitable in all respects for the application and complete with a nylon element, replaceable cartridge type air filter, internally adjustable limit stops for maximum and minimum settings, a cover, and required mounting and connection accessories.
 - .2 Electric humidistats are to be line voltage (115 volt), or 24 volt electronic type.
 - .3 Wall mounting humidistats are to be complete with a tamper-proof display type cover.
 - .4 Duct mounting humidistats are to be complete with a display type cover, duct sampling chamber with 300 mm (12") long extruded pick-up tube for duct mounting, a moulded mounting base, and a ventilated cover.
- .14 Hardware to permit building automation system control and monitoring of input/output points in accordance with Section entitled Building Automation System, points schedule, and drawing control diagrams and operation sequences. All such hardware is to be suitable in all respects for interface with the building automation system.

2.04 SYSTEM WIRING MATERIALS

- .1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in appropriate Section(s) of Electrical Work specification.

3 EXECUTION

3.01 DEMOLITION

- .1 Perform required control system demolition work.
- .2 Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.02 GENERAL RE: INSTALLATION OF CONTROLS

- .1 Provide complete systems of control and instrumentation to control and supervise building equipment and systems in accordance with this Section and drawings.
- .2 Control systems are to generally be as indicated on drawing control diagrams and are to have all the elements therein indicated or implied.
- .3 Control diagrams show only the principal components controlling the equipment and systems. Supplement each control system with all relays, transformers, sensors, etc., required to enable each system to perform as specified and to permit proper operation and supervision.

3.03 SUPPLY AND INSTALLATION OF CONTROL AIR DAMPERS AND OPERATORS

- .1 Unless otherwise specified, supply required control dampers. Hand dampers to sheet metal trade at site in location where they are required for installation as part of sheet metal work. Ensure each damper is correctly located and mounted.
- .2 Provide linkage and operators for dampers. Wherever possible locate damper operators so they are accessible from outside duct, plenum, and equipment casings. Bracket mount operators on ducts or plenums clear of insulation where applicable.
- .3 Where sequence operation is indicated, or where multiple operators drive a series of dampers, provide pilot positioners to couple their action.
- .4 Ensure dampers located in ductwork other than galvanized steel are constructed of type 316 stainless steel.

3.04 SUPPLY AND INSTALLATION OF AUTOMATIC CONTROL VALVES AND OPERATORS

- .1 Unless otherwise specified, supply required automatic control valves. Hand valves to appropriate piping trades at site in locations they are required for installation as part of piping work. Ensure each valve is properly located and installed.
- .2 Mounting of valves in piping, unless otherwise noted, will be done as part of the piping work specified in preceding Sections of this Division of the Specification. Make the valves available at the site, at the locations where they are required, and ensure that each valve is properly mounted.
- .3 Provide an operator from each valve, connect complete, check and test operation, and adjust as required.

3.05 SUPPLY OF ACTUATORS, CONTROLLERS, AND TRANSFORMERS FOR TERMINAL UNITS

- .1 Supply required 24 volt actuators, controllers, and transformers for terminal units.
- .2 Deliver actuators and controllers to successful terminal unit manufacturer's factory.
- .3 Coordinate delivery of product with General Contractor and successful terminal unit manufacturer.

3.06 INSTALLATION OF THERMOSTATS

- .1 Unless otherwise noted, provide required thermostats.
- .2 Provide a ventilated clear polycarbonate cover for each thermostat located in finished areas, and a wire type guard for each thermostat located in unfinished areas and in areas such as mechanical rooms where thermostat is subject to damage.
- .3 Unless otherwise indicated, mount room thermostats in accordance with requirements of local governing authority and, where applicable, barrier-free requirements. Review exact location of thermostats with Consultant prior to roughing-in.
- .4 Provide stand-off mounting and an insulated sub-base for thermostats on outside walls.
- .5 Perform control wiring associated with installation of electric or electric-electronic thermostats.

3.07 INSTALLATION OF CONTROL SYSTEM COMPONENTS

- .1 Provide required control system components and related hardware. Refer to drawing control diagrams and sequences.
- .2 Where components are pipe, duct, or equipment mounted supply components at proper time, coordinate installation with appropriate trade, and ensure components are properly located and mounted.

3.08 CONTROL WIRING

- .1 Perform required control wiring work for control systems except:
 - .1 power wiring connections to equipment and panels, except as noted below;
 - .2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;
 - .3 starter interlock wiring.
- .2 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2') connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.
- .3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.

- .4 Wiring work is to be in accordance with certified wiring schematics and instructions, and wiring standards specified in appropriate Sections of Electrical Work Specification.

3.09 IDENTIFICATION AND LABELLING OF EQUIPMENT AND CIRCUITS

- .1 Refer to identification requirements specified in Section entitled Basic Mechanical Materials and Methods.
- .2 Identify equipment as follows:
 - .1 enclosures and components: engraved laminated nameplates with wording listed and approved prior to manufacture of nameplates;
 - .2 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings.

3.10 TESTING, ADJUSTING, CERTIFICATION, START-UP, AND TRAINING

- .1 When control work is complete, check installation of components and wiring connections, make any required adjustments, and coordinate adjustments with personnel doing HVAC testing, adjusting and balancing work.
- .2 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .3 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .4 Include for 2 full, 8 hour days on-site operation demonstration and training sessions. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.
- .5 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full, 8 hour day to provide additional system training as required, and to demonstrate troubleshooting procedures.

END OF SECTION

ELECTRICAL SPECIFICATIONS

DDSB Brock High School Renovations

DURHAM REGIONAL ROAD 12, CANNINGTON, ON

DDSB Tender #: T26-32

Project #: 25184

Revision 00

April 28, 2026



RDZ ENGINEERS LIMITED
17A - 30 Pennsylvania Avenue
Vaughan, Ontario
L4K 4A5

April 28, 2026	0	ISSUED FOR PERMIT & TENDER	FH	FH
Date	Revision	Description	Prep. By	Check By

DIVISION 26	ELECTERICAL
SECTION 26 05 00	FORM OF SUPPLEMENTARY ELECTRICAL TENDER
SECTION 26 05 01	ELECTRICAL WORK GENERAL INSTRUCTIONS
SECTION 26 05 21	WIRES AND CABLES
SECTION 26 05 28	GROUNDING
SECTION 26 05 31	SPLITTERS, JUNCTION, PULL BOXES AND CABINETS
SECTION 26 05 32	OUTLET BOXES, CONDUIT BOXES AND FITTINGS
SECTION 26 05 33	SURFACE RACEWAYS
SECTION 26 05 34	CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS
SECTION 26 05 41	SEISMIC BRACING FOR ELECTRICAL EQUIPMENT
SECTION 26 08 10	ACCESS PANELS
SECTION 26 08 20	ELECTRIC HEATING SYSTEM
SECTION 26 08 40	BUILDING AUTOMATION SYSTEM
SECTION 26 08 50	HAND DRYERS
SECTION 26 09 24	LIGHTING CONTROL DEVICES
SECTION 26 24 16	PANEL BOARDS
SECTION 26 27 26	WIRING DEVICES
SECTION 26 28 13	FUSES
SECTION 26 28 23	DISCONNECT SWITCHES-FUSED AND NON-FUSED
SECTION 26 29 01	CONTACTORS
SECTION 26 29 10	MOTOR STARTERS
SECTION 26 50 00	LIGHTING
SECTION 26 52 00	EMERGENCY LIGHTING
DIVISION 27	COMMUNICATIONS
SECTION 27 51 16	PUBLIC ADDRESS SYSTEM
DIVISION 28	ELECTRONIC SAFETY AND SECURITY
SECTION 28 46 00	FIRE DETECTION AND ALARM SYSTEM
SECTION 28 46 01	FIRE DETECTION AND ALARM SYSTEM VERIFICATION

END OF SECTION

1. General

1.1 GENERAL

- .1 This Section covers items common to Sections of Division 26, Division 27, and Division 28. The General Conditions, Supplementary Conditions and Division 1 are a part of this Specification and shall apply to this Division. This section also supplements requirements of Division 1, Division 23, Division 27, Division 28, Division 33, and Division 34.
- .2 Issued for Construction documents are issued for Contractors' convenience for reference only and are a consolidation of issued drawings, specifications, and addenda. Consultant makes no representation of their completeness. Exact construction requirements to be based on official Bid issued drawings, specifications, and issued separate addenda. Contact Consultant for any clarifications.

1.2 APPLICATION

- .1 This Section specifies requirements that are common to Electrical Divisions work Sections, and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or 01 to take precedence.
- .2 Mention herein, or indication on the Drawings of articles, materials, operations, or methods requires that all such items shall be provided in the quality and quantity required, and that the operations shall be performed according to the methods prescribed, complete with all necessary labour and incidentals.
- .3 These Specifications shall be considered as an integral part of the accompanying Drawings. Any item or subject omitted from either the Specifications or the Drawings, but which is mentioned or reasonably specified in the other shall be considered as properly and sufficiently specified and shall be provided.

1.3 REFERENCES

- .1 All work shall conform to the latest Codes, requirements and approval of the Authorities having jurisdiction and shall be subject to acceptance by the Consultant, and the following codes and standards:
 - OBC, Latest Edition and Local Building Department requirements.
 - Ontario Fire Marshall latest requirements.
 - OESC – Latest Edition
 - Electrical Safety Authority – Latest Inspection Bulletins
 - CSA C22.1, Canadian Electrical Code, Part 1 - Latest Edition

1.4 DEFINITIONS

- .1 The following are definitions of words found in Electrical Divisions of the Specification and on associated drawings:
 - .1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
 - .2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
 - .3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
 - .4 "provision" or "provide" (and tenses of "provide") – means supply and install complete. Include labour, materials, and services necessary to supply and install items or work referred to.

- .5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify, and certify.
 - .6 "As instructed" or where instructed" – means as instructed by the Consultant including supplementary instruction notices and job site instruction notices.
 - .7 "listed" - means that the materials or equipment has been tested in accordance with applicable standards and methods and has been approved and listed for the intended use by a testing company approved by the Authorities having jurisdiction.
 - .8 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery, and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties, and assistance to Contractor.
 - .9 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, remove obsolete materials and patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by consultant.
 - .10 "BAS" – means building automation system; "BMS" – means building management system, "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS" and "DDC" generally mean same.
 - .11 "Governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules, and regulations that apply to and govern work and to which work must adhere.
 - .12 "Mechanical Divisions" – refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
 - .13 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
 - .14 "Approved" or "Approval" - means approved by Authorities having jurisdiction as conforming to Codes, Standards, By-Laws, etc.
 - .15 "Acceptable" or "Acceptance" – means acceptable to the Consultant as conforming together to the requirements of the contract documents.
 - .16 "Submit for Review" or "Submit Notice" – means submit to the Consultant.
 - .17 "Subject to Review" – means work shall be laid out for review by the Consultant. No work shall proceed until instructions have been obtained from the Consultant. Submit further information, shop drawings, samples etc. as specified and as may be requested by the Consultants.
 - .18 "Accessible" - means reachable by person with tools as required and where obstacles may be removed and replaced without cutting or breaking out materials.
 - .19 "board", "owner" - means School board.
- .2 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.
- .3 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.5 DOCUMENTS

- .1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.

- .2 Drawings and Specifications are portions of Contract Documents and identify labour, products, and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
- .3 Read Drawings and Specifications in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.
- .4 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Electrical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.
- .5 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.
- .6 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations, and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.
- .7 Locations of equipment and materials shown may be altered, when reviewed by consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.
- .8 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa in Specification.
- .9 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid submission and confirm exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .10 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered a contract and there are no representations of any kind made by consultant to any other party.
- .11 When scale and date of Drawings are the same, or when discrepancy exists within Specification, include most costly arrangement to take precedence.
- .12 Unless otherwise specified in Division 00, Division 01, or "General Conditions", in the case of discrepancies or conflicts between Drawings and Specification, documents will govern in following order:
 - .1 Specification.
 - .2 Drawings of larger scale.
 - .3 Drawings of smaller scale.
 - .4 Drawings of later date when scale of Drawings is same.

1.6 IMPERIAL AND METRIC MEASUREMENTS

- .1 Generally, both metric and imperial units of measurement are given in Sections of Specification governed by this section. Measurement conversions may be generally "soft" and rounded off. Exact measurements to be confirmed based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable local code requirements, and/or as applicable, make accurate measurements onsite. Where significant discrepancies are found, immediately notify Consultant for direction.

1.7 EXAMINATION OF DOCUMENTS AND EXISTING SITE CONDITIONS

- .1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work and include for such conditions in Bid Price.
- .2 Carefully examine electrical, structural, mechanical, and architectural drawings, and fully understand the functioning of the system described and specified under this Section. If in doubt, contact the engineer before submitting the Bid Price.
- .3 Report to Consultant, prior to Bid Submittal, any existing site condition that will or may affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.
- .4 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, immediately notify Consultant, in writing.

1.8 WORK STANDARDS

- .1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction are quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards, or amendments issued by local governing authorities.
- .2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by consultant.
- .3 Supplementary mandatory specification and requirements to be used in conjunction with project include but are not limited to following:
 - .1 Ontario Building Code (OBC)
 - .2 Electrical Safety Authority (ESA)
 - .3 Ontario Electrical Safety Code (OESC)
 - .4 Canadian Standards Association (CSA)
 - .5 Underwriters' Laboratories of Canada (ULC)
 - .6 National Standards of Canada (CAN)
 - .7 National Building Code of Canada (NBC)
 - .8 National Fire Protection Association (NFPA)
 - .9 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE)
 - .10 National Electrical Manufacturers Association (NEMA)
 - .11 Electrical and Electronic Manufacturers Association of Canada (EEMAC)
 - .12 American National Standards Institute (ANSI)
 - .13 Illuminating Engineering Society (IES)
 - .14 Building Industry Consulting Services, International (BICSI)
 - .15 Electronic Industries Association (EIA)
 - .16 Canadian General Standards Board (CGSB)

- .17 Institute of Electrical and Electronic Engineers (IEEE)
 - .18 Occupational Health and Safety Act (OHSA)
 - .19 Technical Standards and Safety Authority (TSSA)
 - .20 Workplace Hazardous Materials Information System (WHMIS)
 - .21 International Standards Organization (ISO)
 - .22 Material Safety Data Sheets by product manufacturers.
 - .23 Local utility inspection permits.
 - .24 Codes, standards, and regulations of local governing authorities having jurisdiction.
 - .25 Additional codes and standards listed in Trade Sections.
 - .26 Owner's standards.
-
- .4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.
 - .5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted. Pay associated costs associated with these submittals.
 - .6 Unless otherwise specified, equipment is to be installed in accordance with the equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.
 - .7 Work is to be performed by journeyperson tradesmen who perform only the work that their certificates permit, or by apprentice tradesmen under direct on-site supervision of an experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined as stated in Ontario College of Trades and Apprenticeship Act.
 - .8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review by consultant at any time.
 - .9 Experienced and qualified superintendent is to be on-site at times when work is being performed.
 - .10 Coordinate work inspection reviews and approvals with governing inspection department to ensure that construction schedule is not delayed. Be responsible for prompt notification of deficiencies to consultant and submission of reports and certificates to consultant.
 - .11 Properly protect equipment and materials on site from damage due to elements and work of trades, to satisfaction of consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.
 - .12 Electrical equipment and devices shall be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.
 - .13 Makes and quality of the materials used shall be approved by the Consultants and authority having jurisdiction.
 - .14 Products and materials provided shall be new and free from all defects. Related materials shall be of the same manufacturer throughout the Project.
 - .15 Products and materials called for on the drawings or in the specifications by trade names, manufacturer names and catalogue reference are those which shall be used based on the Tender.

- .16 Alternative products and materials to those specified shall only be considered if they are shown in the Tender as a material variation with an appropriate price adjustment. The Consultant reserves the right to accept or reject any alternative without explanation.
- .17 Assume full responsibilities for ensuring that when providing alternative products or materials, all space, weight, connections, power, and wiring requirements, etc., are considered. Any costs incurred for additional components, changes to services, structural or space requirements, layouts, and plans, etc., that may be necessary will be borne by this Division.
- .18 Materials or equipment rejected by the Consultants shall be immediately removed from the project and suitable materials shall be provided.

1.9 PERMITS, CERTIFICATES AND FEES

- .1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities. Obtain and pay for permits, certificates, and approvals required to complete Work.
- .2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work.
- .3 Submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities.
- .4 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities to certify that completed Work is in accordance with regulations of regulatory authorities and is acceptable to them.

1.10 REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

- .1 Professional engineers retained to perform consulting services with regards to Project work, i.e., seismic engineer, fire protection engineer, structural engineer, are to be members in good standing with local Association of Professional Engineers and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
- .2 Retained engineer's professional liability insurance is to protect Contractor's Consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned Consultants and their respective servants, agents, and employees in regard to the Work of this Contract.
- .3 Liability insurance requirements are as follows:
 - .1 coverage is to be a minimum of \$1,000,000.00 inclusive of any one occurrence.
 - .2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice.
 - .3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work.
 - .4 retained Consultants are to ascertain that Sub-Consultants employed by them carry insurance in the form and limits specified above.
 - .5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned Consultant's services.

1.11 WORKPLACE SAFETY

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required and maintain one copy at site in a visible and accessible location available to personnel.
- .2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces".

1.12 PLANNING AND LAYOUT OF WORK

- .1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:
 - .1 large ducts (main runs)
 - .2 cable tray and bus duct
 - .3 conduit 100 mm (4") dia. and larger
 - .4 smaller branch ductwork
 - .5 conduit less than 100 mm (4") dia.
- .3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of the work.
- .4 Do not use Contract Drawing measurements for distribution equipment layout, conduit installation work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established benchmarks for both horizontal and vertical measurements. Coordinate with and make allowances for work of other trades. Accurately layout work and be entirely responsible for work installed in accordance with layout drawings. Where any grade or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.
- .5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or ¼"=1' 0") of the work for coordination with General Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, disks of engineering drawings for this use. Prints and/or disks of Contractors' interference drawings are to be distributed among other Trade Contractors and General Contractor. Submit drawings to consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.

- .6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
- .7 Junction boxes for lighting, power, fire alarm, power packs, lighting controllers and such other systems devices and products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- .8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination by this Division.

1.13 COORDINATION OF THE WORK

- .1 Fully understands the functions of the systems specified and have no doubts regarding the extent of the Contract.
- .2 Examine the Architectural, Structural, Mechanical and Electrical drawings and become fully familiar with the work of other Divisions.
- .3 Co-ordinate with all Divisions providing equipment and services and ensure that there is no confliction. Coordination requirements are to include but not be limited to following:
 - .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work.
 - .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.
 - .3 depth and routing of excavation required for work, and requirements for bedding and backfill.
 - .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.
- .4 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes to enter building and be moved into spaces where they are to be located without difficulty.
- .5 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building and protected from elements.
- .6 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.
- .7 Arrange equipment in proper relation with other apparatus, the building construction, the Architectural finish and with all work specified.
- .8 Where space is shown for future equipment leave such space clear and ensure that the necessary connections can be made to the future equipment.
- .9 Where work is to be integrated or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

- .10 Failures to fully understand Drawings and allow for the work of other Divisions or where relocations are necessary due to lack of co-ordination between Divisions shall be remedied at the expense of this Division.

1.14 WORKMANSHIP

- .1 All work shall be executed in a workmanlike manner and present a neat mechanical appearance.

1.15 EQUIPMENT AND MATERIALS

- .1 Be responsible for ordering of products (equipment and materials) in a timely manner to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.
- .2 Provide Canadian manufactured products wherever possible and where required quality and performance is obtainable. Unless otherwise specified, all materials and apparatus shall be new and shall comply with applicable Canadian Standards Association (CSA) Standards and/or Underwriters Laboratories of Canada (ULC) Standards and the requirements of the authorities having jurisdiction.
- .3 Materials and equipment scheduled and/or specified, have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for material and equipment, specified by manufacturer's name and model number. Unless otherwise noted, the Bid Price may be based on materials and equipment supplied by any of the manufacturers named as acceptable for the particular material or equipment. If acceptable manufacturers are not stated for a particular material or piece of equipment, base the Bid Price on material supplied by the base specified manufacturers.
- .4 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Note that above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.
- .5 If materials or equipment supplied by a manufacturer named as acceptable are used in lieu of the manufacturer specified, be responsible for ensuring that the substituted material or equipment is equivalent in quality, performance and operating characteristics (including energy consumption if applicable) to the specified materials or equipment, and, it shall be understood that any additional costs, and changes to associated or adjacent work resulting from provision of materials supplied by a manufacturer other than the specified manufacturer is included in the Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of specified equipment and the dimension of such equipment differs from the specified equipment, prepare, and submit for review, accurately dimensioned layouts of rooms affected.

- .6 In addition to the manufacturers specified or named as acceptable, other manufacturers of materials or equipment may be proposed to the Consultant for acceptance, listing in each case a corresponding credit for each alternative proposed, however, the Bid Price must be based on equipment, or materials specified or named as acceptable. Certify in writing to the Consultant that the proposed alternative meets all space, power, design, energy consumption, and all other requirements of the specified or acceptable material or equipment. In addition, it shall be understood that there will be no increase in the contract Price by reason of any changes to associated equipment, mechanical and/or electrical, required by acceptance of proposed alternatives. The Consultant has sole discretion in accepting any such proposed alternative material or equipment.
- .7 Where products you intend to provide are proposed as "an equal" and/or "or approved equal", to specified products, certify in writing that the proposed product to be used in lieu of specified product, at least meets space, power, design, energy consumption, noise criteria and other requirements of the specified product and thus shall be equivalent to or better than the specified product. When requested by the Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or equal" and/or "or approved equal" products shall be at the sole discretion of the Consultant. The Consultant's decision shall be final and shall not require explanation. There shall be no increase in the contract Price due to the Consultant's rejection of a proposed equivalent product.
- .8 Only base specified products specified acceptable products or equipment listed as alternate will be considered for acceptance by the owner. No proposed substitutions will be accepted.
- .9 Indicate in Form of Supplementary Electrical Tender, names of manufacturers for proposed products to be supplied, and which were based specified or scheduled with a manufacturer's name. Names of proposed manufacturers on list must be one of names stated as acceptable for products unless prior approval from Owner has been given for use of products by other manufacturers. Submit to Consultant for review as directed.

1.16 SHOP DRAWINGS

- .1 At start-up meeting, confirm with consultant products to be included in shop drawing submission. Prepare and submit list of products to consultant for review.
- .2 Submit for review, drawings showing in detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:
 - .1 Product literature cuts.
 - .2 Equipment data sheets.
 - .3 Equipment dimension drawings.
 - .4 System block diagrams.
 - .5 Sequence of operation.
 - .6 Connection wiring schematic diagrams.
 - .7 Functionality with integrated systems.
- .3 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification section reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
- .4 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.

- .5 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated, and signed will be returned to be resubmitted. Submit electronic copies of shop drawings unless otherwise directed by consultant. Confirm exact requirements with consultant.
- .6 Approval of a drawing by this Division implies the following:
 1. The drawing has been checked by the person making the approval.
 2. The equipment or material complies in all respects with the requirements of the specifications and drawings.
 3. The quantities, if indicated on the drawing, are correct.
 4. The physical dimensions of the components are such that they can be installed without interference with the building structure or other equipment, and that, after installation, there are sufficient clearances on all sides for the maintenance, servicing, and operation of the equipment.
- .7 Consultant will review shop drawings and indicate review status by stamping shop drawing copies as follows:
 - .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing.
 - .2 "REVISE AND RESUBMIT" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.
- .8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each shop drawing or product data sheet submitted:

"THIS REVIEW BY CONSULTANT IS FOR THE SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAIL DESIGN INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR, AND SUCH REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR COORDINATION OF WORK OF SUB-TRADES."
- .9 Resubmit any drawing on which notations have been made, after it has been modified or corrected.
- .10 Drawings that are re-submitted shall have a distinct notation of the fact made on each drawing.
- .11 Works shall not proceed on any equipment, material or installation until the drawings have been reviewed by the Consultant.
- .12 Each system and each major component are to be separate shop drawing submissions. Shop drawings for common devices such as devices of each system are to be submitted together.

- .13 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.
- .14 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.

1.17 EQUIPMENT LOADS

- .1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to consultant, via shop drawing submissions, prior to construction.
- .2 When choice of specific equipment is made by Contractor, actual weight, location, and method of support of equipment may differ from those initially given to consultants and thus from those assumed for design. Consequently, it is necessary to back-check equipment loads, location, and supports.
- .3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Be responsible for confirming locations of equipment with consultant prior to construction.

1.18 OPENINGS

- .1 Supply opening sizes and locations to consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
- .2 No openings are permitted through completed structure without written approval of consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to consultant for review, well in advance of doing work.
- .3 Chases, openings, cutting, patching, etc. shall be provided by this Division in accordance with those sections of the specification detailing the requirements.
- .4 Flashing required for openings in walls, floors and roofs shall, unless otherwise noted, be provided by this Division.
- .5 Electrical conduit roof flashing shall be similar to National Roofing supply product code# ECP-PVCH (electrical conduit post PVCH), Gooseneck S.S.A ARPGN2 (2")/ ARPGN3 (3").
- .6 Drilling for hangers, rods, inserts and work of a similar nature shall be provided by this Division.
- .7 Provide all necessary sleeves, inserts, anchor bolts, etc., prior to pouring of concrete or building of walls, roofs, etc.
- .8 Advise the extent of such work and supply all information and details as to sizes and locations within thirty days after the award of the Contract.
- .9 Failures to comply with the above requirements shall be remedied at this Division's expense.
- .10 Where conduits pass through fire rated walls/ areas, proper fire stop material shall be used by Division 26. Submit shop drawings for review before installation.

1.19 SCAFFOLDING, RIGGING, AND HOISTING

- .1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to review by and coordination with consultant.

- .2 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.
- .3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from consultant.

1.20 TEMPORARY CRANES

- .1 Submit following to consultant for review:
 - .1 Propose details showing existing structures and surfaces being used for lifting locations.
 - .2 Copies of approvals of authorities for work.
 - .3 Copies of approvals of property management of buildings affected by hoisting work, allowing for work.
 - .4 Copies of required insurance for work.

1.21 CHANGES OR REVISIONS TO THE WORK

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of work from that required by Contract Documents, prepare, and submit to consultant for approval, a quotation being proposed cost for executing change or revision.
- .2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 If overhead and profit percentages are not specified in Division 00 or 01, but allowable under Contract as confirmed with consultant prior to contract signing, then allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.
- .4 Unless otherwise specified in Divisions 00 or 01, following requirements apply to all quotations submitted:
 - .1 When change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work.
 - .2 Material costs are not to exceed those published in local estimating price guides.
 - .3 Electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labour Units.
 - .4 Costs for journeyman and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work.
 - .5 Cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision and change or revision must be such that site superintendent's involvement is necessary.
 - .6 Costs for rental tools and/or equipment are not to exceed local rental costs.
 - .7 Overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals.
 - .8 Quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.

- .6 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.
- .7 Do not execute any change or revision until written authorization for the change or revision has been obtained from consultant.

1.22 BREAKDOWN OF ELECTRICAL WORK COST

- .1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.
- .2 Payment breakdown is subject to Consultant's approval and progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including system testing and verification, and project closeout submittals.
- .3 Indicate equipment, material, and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.

1.23 NOTICE FOR REQUIRED FIELD REVIEWS

- .1 Whenever there is a requirement for consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to consultant.
- .2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until consultant advises that it may be concealed.
- .4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.24 PRELIMINARY TESTING

- .1 When directed by consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.
- .2 When, in Consultant's opinion, tests are required to be performed by a certified testing agency, arrange, and pay for such tests.
- .3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.
- .4 When, in Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.

1.25 PROVISIONS FOR SYSTEMS/EQUIPMENT USED DURING CONSTRUCTION

- .1 Confirm with Consultant what equipment can be used during construction.

- .2 Any system or piece of equipment that is specified to be provided under requirements of Documents and is required to be used during construction stages of work prior to issuing of Certificate of Substantial Performance of the Work, are to be provided with special interim maintenance and service to cover systems/equipment during time of use during construction period of project until project has been certified as substantially performed and such systems/equipment are turned over to Owner.
- .3 During this period of construction, such systems/equipment to not become property of Owner or be Owner's responsibility for maintenance or service. Systems/equipment are to remain property of respective manufacturers/suppliers or Contractor, who are responsible for full maintenance and servicing of systems/equipment in order to maintain validity of warranties after turning over to Owner.
- .4 Prior to application for a Certificate of Substantial Performance of the Work and turn over to Owner, such systems/equipment to be cleaned, restored to "new" condition, paint finishes "touched up" etc.

1.26 MAINTAINING EQUIPMENT PRIOR TO ACCEPTANCE

- .1 Maintain equipment in accordance with the manufacturer's printed instructions prior to start-up, testing, and commissioning.

1.27 PROTECTION

- .1 Protect all finished and unfinished work from damage due to carrying out the work specified.
- .2 Repair all damage resulting from execution of the work to the satisfaction of the Consultant.
- .3 Should the project be stopped for any cause, provide all necessary protection to prevent damage by weather or other causes while such stoppage exists.

1.28 HANDLING AND STORAGE

- .1 Materials and equipment shall be handled and stored in such a manner so that no damage shall be done to the materials, the structure of the building or surrounding property.
- .2 Packaged or bundled materials and equipment shall be stored in dry weathertight secure enclosures in original undamaged condition with manufacturer's seals and labels intact.
- .3 All metals shall be protected against corrosion and bending.
- .4 Storage of materials, equipment etc. in the building structure shall not be permitted unless otherwise noted.

1.29 MINOR FIELD CHANGES

- .1 The location, arrangement and connection of equipment and materials as shown on the drawings represents a close approximation to the intent and requirements of the Contract.
- .2 The right is reserved to make reasonable changes required to accommodate conditions arising during the progress of the work. Such changes, if made prior to the installation, shall be done at no additional cost, unless the location, arrangement or connection is more than six feet from that shown on the drawings.

1.30 CLEANING UP

- .1 During construction, and daily, keep the site reasonably clear of rubbish and waste material resulting from electrical work to the satisfaction of the Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove all rubbish and debris, and arrange for and pay for the repair of any damage caused as a result of electrical work.
- .2 Clean the interior and exterior of all equipment and remove any debris during construction.
- .3 Inspect and clean all systems and equipment prior to energizing and ensure that they are safe.

Perform a complete and thorough clean-up to the exterior and interiors of all systems and equipment before the final inspection. The interiors shall be cleaned using an industrial vacuum cleaner.

1.31 ELECTRICAL CONDUCTOR FIRE PROTECTION

- .1 Fire rated enclosures shall be provided to form service spaces for conduits containing electrical conductors for emergency power, elevators, and life safety equipment in accordance with the requirements of the Authorities having jurisdiction.
- .2 Fire rated access panels shall be provided in the enclosures where required.
- .3 The fire rated enclosures required by this Division shall, unless otherwise noted, be provided by this Division and shall be in accordance with the sections of the specification detailing the fire rated enclosures requirements.
- .4 Advise the extent of the fire rated enclosures required and supply all information and details as to size and locations within thirty days after the award of the contract.
- .5 Failures to comply with the above requirements shall be remedied at this Division's expense.
- .6 Where fire rated cables, that comply with the requirements of the Authorities having jurisdiction, are provided it shall not be required that they be installed in fire rated enclosures.

1.32 SPRINKLER PROOF EQUIPMENT

- .1 Where sprinklers are installed; electrical equipment shall be constructed so that water from the sprinkler heads shall not impair the effectiveness of the equipment.
- .2 A separate and complete roof shall be provided on free standing or surface mounted equipment. An overhang at the front, rear and sides shall prevent the entrance of water either at the top or through projecting face plates, meters, etc. Provide complete gaskets to suit.
- .3 Where openings are required in the roofs or sides of incoming and outgoing conduits and cables, removable gasketed plates shall be provided and the conduits and cables shall be installed using waterproof fittings. The plates are to be grounded by a separate copper strap to the equipment.
- .4 Distribution and power panels, panel boards, etc. and switchboards shall be complete with gaskets and doors.

1.33 EQUIPMENT AND MATERIAL COLOURS

- .1 Where materials and equipment are specified to be a specific colour, a sample of the colour proposed by the manufacturer shall be submitted with the shop drawing.

- .2 Where materials and equipment are specified to be of colours as selected by the Consultant, these shall be determined during the Contract. Obtain the colour requirements from the Consultant prior to submitting shop drawings so that the appropriate sample of the colour can be submitted with the shop drawings.

1.34 SLEEVES

- .1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- .2 For wall partitions and ceilings, the ends of the sleeves shall be flush with the finish on both sides. For floors they shall extend 50mm above and below finished floor level.
- .3 The space between the sleeve and the conduit and spare sleeves shall be filled with Dow Corning silicone RTV foam for fire stop. Caulk around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound.

1.35 EXCAVATION AND BACKFILL

- .1 The excavation and backfill required by this Division shall, unless otherwise noted, be provided by this Division and shall be in accordance with the Sections of the Specification detailing the excavation and backfill requirements.
- .2 Advise the extent of the excavation and backfill work required by this Division and supply all information and details as to size and locations within thirty days after the award of the Contract.
- .3 Failures to comply with the above requirements shall be remedied at this Division's expense.

1.36 HOUSEKEEPING PAD

- .1 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads which shall, unless otherwise noted, be provided by this Division.
- .2 Advise the extent of the housekeeping pads required by this Division and supply all information and details as to size and location within thirty days after the award of the Contract.
- .3 Failures to comply with the above requirements shall be remedied at this Division's expense.

1.37 CONCRETE

- .1 The concrete and reinforcing required by this Division shall, unless otherwise noted, be provided by this Division and shall be in accordance with the Sections of the Specifications detailing the concrete and reinforcing requirements.
- .2 Advise the extent of the concrete and reinforcing work required by this Division and supply all information and details as to size and locations within thirty days after the award of the Contract.
- .3 Failures to comply with the above requirements shall be remedied at this Division's expense.

1.38 PAINTING

- .1 All equipment shall be supplied with manufacturer's standard finish coat, unless otherwise noted.
- .2 All supports, hangers, etc. provided or fabricated by this Division shall be painted with two coats of zinc chromate primer.
- .3 Where the finish on any materials or equipment installed by this Division is damaged, it shall be touched up, completely repainted or replaced to the satisfaction of the Consultant.

1.39 IDENTIFICATIONS

- .1 Identify each item of equipment installed by this Division, whether supplied by it or not.
- .2 Metal surfaces shall be thoroughly cleaned before application of identification.
- .3 Identifications shall be installed after painting has been completed and shall be secured with self-tapping screws or rivets except when installed on the inside of doors when gluing will be acceptable.
- .4 Manufacturer's nameplates shall be affixed to each item supplied showing the size, name of equipment, serial number and all information usually provided including voltage, cycle, phase, horsepower, etc., and the name of the Manufacturer and his address. Ensure that all stamped, etched, or engraved lettering on plates is perfectly legible. Do not paint over nameplates and where equipment is to be concealed attach the nameplates in an accessible location.
- .5 Panels and all other equipment which have exposed faces in finished areas shall not have any visible trademarks or other identifying symbols. Nameplates shall be mounted on the inside of the doors.
- .6 Each lighting panel shall have a directory mounted on the inside of the door behind a protective plastic screen. The directories shall be typewritten and shall identify each branch circuit used. Spares and spaces shall be noted in pencil.
- .7 The nameplates for switchboards, distribution panels, power panels, etc. shall be Lamicoid with 13mm high letters with typical identification of e.g., "PP'AA, 600V 3 PH., 4W, fed from Switchboard 'A'".
- .8 The nameplates for panel boards shall be Lamicoid with 9.5mm high letters with typical identification of: e.g., "LP'B', 208V, 3Ph, 4W, fed from PP'A".
- .9 Each breaker, switch, instrument, meter, etc. in switchboards, distribution panels, power panels, etc. shall have a Lamicoid nameplate with 6.4mm high letters with typical identification of: e.g., "Elevator #1" or "Pump-1A".
- .10 The nameplates for disconnect switches, starters, time clocks, dimmers etc. shall be Lamicoid with 6.4mm high letters with typical identification of: e.g., "Supply Fan 'S4", 5 HP, 600V, 3Ph., 3W, fed from 'PP-1'".
- .11 Each feeder cable and feeder conduit shall be identified with 25mm high letters with typical identification of "208V, 3Ph, 4W to LP'B". The identification shall be provided at each access door, each change of direction, each junction box, at each floor or platform for vertically exposed conduits or cables at 2 metres above floor, at not more than 15 metres apart in straight runs, and on both sides of sleeves through walls.
- .12 The interior, exterior and lids of all junction boxes and outlet boxes shall be neatly identified with different colours of paint. The colours shall be consistent throughout the project for the following systems:
 - .1 347/600 Volt System – Black
 - .2 120/208 Volt System – Blue
 - .3 120/208 Volt Lighting – Yellow
 - .4 120/208 Volt Emergency Lighting System – Orange
 - .5 Intrusion Detection System – Purple
 - .6 Computer System – Pink
 - .7 Fire Detection and Alarm System – Red
 - .8 Telephone System – Brown
 - .9 P.A./Telephone System – Green

- .10 Cable TV – White (Co-ordinate with the Board)
 - .13 Provide all signs and marking of equipment as required by the Authorities having jurisdiction.
 - .14 Outlet boxes for light switch(es) and receptacle(s) and junction boxes provided for lighting or power connections shall be identified on the box cover with circuits contained in the box, the panels from which they are fed, the voltage and the purpose of the outlet.
 - .15 Each power switch and receptacle shall be complete with permanent printed adhesive label installed on faceplate, identifying panel and circuit from which it is fed.
- 1.40 MOCK-UP
- .1 A mock-up of the ceiling shall be provided by another Division of the Specification.
 - .2 Provide samples of the lighting fixtures, fire alarm devices and all other items of equipment mounted in or on the ceiling and obtain acceptance for the samples and their installation.
- 1.41 TEMPORARY AND TRIAL USAGE
- .1 When it is claimed that a portion of the work is completed and in accordance with the Drawings and Specifications, the Owner shall have the privilege of temporary and trial usage for a reasonable length of time for making a complete and thorough test of the portion of the work completed.
 - .2 Temporary or trial usage by the Owner of any electrical device, machinery, apparatus, equipment or any other work or materials supplied under this Contract before final completion and written acceptance, is not to be construed as evidence of acceptance of same.
- 1.42 RECORD (AS-BUILT) DRAWINGS
- .1 Drawings for this project have been prepared on a CAD system using AutoCAD software of release version confirmed with consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from consultant by paying \$1,000. Drawings may also to be used for preparation of layouts and interference drawings.
 - .2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes, and deviations from routing of services and locations of equipment shown on Contract Drawings, daily. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep always set up to date, and ensure set is always available for periodic review. As-built set is also to include the following:
 - .1 Dimensioned location of inaccessible concealed work.
 - .2 Locations of control devices with identification for each.
 - .3 Location of all pull boxes and junction boxes.
 - .4 Locate, with dimensions to the building grid and datum lines, all buried and concealed services, pull boxes, junction boxes, etc. for all systems.
 - .5 Location of all conduits, ducts, wiring, and conductor runs for all systems including sizes, types of components, circuit numbers, etc. exactly as installed.
 - .6 Location of concealed services terminated for future extension.
 - .7 Room names and numbering, equipment names, etc. shall be in accordance with the Owner's designation and may not necessarily be those shown on the drawings.

- .3 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of consultant.
- .4 Reviews of the record drawings by the Consultant shall be for general conformance only and is not an approval of the accuracy of the drawings. Electrical Division shall be responsible for the accuracy of the record drawings.
- .5 Submit final reviewed "as-built" drawing set to consultant to produce final "as-built" CAD drawings for submission to the School Board.
- .6 Transfer all recorded information from marked-up set of As-Built condition to AutoCAD.
- .7 Unless otherwise noted in Divisions 00 or 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of consultant.

1.43 TESTING AND COMMISSIONING

- .1 All systems, equipment and installation shall be inspected, tested, adjusted, and commissioned to ensure compliance with the Drawings, Specifications and the Requirements of the Authorities having jurisdiction.
- .2 Provide testing equipment, instruments, material and labour for all testing and commissioning.
- .3 Submit reports of all testing and commissioning for review by the Consultants.
- .4 This Division shall include for the cost of one qualified serviceman, completely familiar with the project, complete with appropriate spare parts and tools, to become part of the commissioning team for the project. The serviceman shall assist the Owner for a total of 60 hours during the commissioning process. This work will be required at or near the substantial completion phase of the project. Each Division and/or trade providing serviceman shall ensure continuity of their function by having only one such person assigned to the commissioning team.
- .5 The actual performance of this work will be scheduled and coordinated by the Owner.

1.44 SYSTEM ACCEPTANCES

- .1 Prior to requesting final inspection, submit, for review by the Consultant, letters from the manufacturers of equipment and systems indicating that their Technical Service Representatives have inspected and tested the equipment and systems and are satisfied with the methods of installation, connections, and operation.
- .2 Acceptance letters shall be submitted for the following, when applicable:
 - .1 Switchboard
 - .2 Distribution Panels
 - .3 Power Panels
 - .4 Panel Boards
 - .5 Fire Detection and Alarm System
 - .6 Emergency Lighting System
 - .7 Intrusion Detection System
 - .8 Video Surveillance System
 - .9 Public Address System
 - .10 Lighting Control System

1.45 INSTRUCTIONS AND DEMONSTRATIONS

- .1 Instruct the Owner's designated personnel during construction and prior to requesting final inspection so that they are fully familiar with all aspects in the function, installation, operation and maintenance of all systems and equipment.
- .2 Arrange for and pay for the services of manufacturer's service technicians, engineers and other personnel required for instruction on specialized systems or installation.
- .3 After commissioning of the systems, equipment, and installation they shall be fully demonstrated by this Division and representatives of the manufacturers to the Authorities having jurisdiction.
- .4 Prior to requesting final inspection submit, for each system, the following:
 - .1 Dates and durations of instructions given to designated personnel and the names of persons instructed.
 - .2 Signature of each person instructed stating that they understand and are familiar with the function, installation, operation, and maintenance of the system.
 - .3 Dates and durations of demonstrations to Authorities having jurisdiction and names of all persons present.

1.46 OPERATING AND MAINTENANCE INSTRUCTION MANUALS

- .1 Supply one hard copy of operating and maintenance (O&M) manuals consolidated in hardcover three "D" ring binders with each binder sized to include approximately 25% spare space for future data. Confirm exact quantity of manuals with consultant. Each binder to include:
 - .1 On front cover: project name; wording – "Electrical Systems Operating and Maintenance Manual"; and date.
 - .2 Introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses.
 - .3 Equipment manufacturer's authorized contact person name, telephone number and company website.
 - .4 Table of Contents sheet, and corresponding Index tab sheets for all electrical specification sections.
 - .5 Copy of each "Reviewed" or clean, updated "Reviewed As Noted" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "REVIEWED AS NOTED" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;
 - .6 Testing and commissioning reports, and certificates issued by governing authorities.
 - .7 Operating data is to include:
 - .1 Demonstration and instruction certificate.
 - .2 Description of each system and its controls.
 - .3 Control schematics for equipment/systems.
 - .4 Description of operation of each system.
 - .5 Operation instruction for each system and each component.
 - .6 Description of actions to be taken in event of emergencies and/or equipment failure.
 - .7 Testing procedures.
 - .8 Trouble finding procedure.
 - .8 Maintenance data is to include:

- .1 Servicing maintenance, operation, and trouble-shooting instructions for each item of equipment and each system.
 - .2 Schedules of tasks, frequency, tools required, and estimated task time.
 - .3 Complete spare parts lists with numbers.
 - .4 Catalogue sheets for all components.
 - .5 Approved shop drawings.
 - .6 Wiring diagram.
 - .9 Copies of warranties.
 - .10 Items requested specifically in Section Articles.
- .2 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner's building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.
 - .3 Before applying for a Certificate of Substantial Performance of the Work, assemble one copy of O&M Manual and submit to consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.
 - .4 Provide 1 digital copies of contents of operating and maintenance manuals and load onto separate USB type flash drives and submit to consultant. Prepare digital copies using version of Adobe Acrobat Portable Document Format or equal as confirmed with consultant and enhanced with bookmarks and internal document links. Each PDF file name shall be the same as that indicated in the binder. The contents in each PDF file shall be searchable.

1.47 COMMISSIONING

- .1 A commissioning Authority will be appointed by the Board/Owner to oversee the commissioning activities of the electrical contract. Cooperate and coordinate with the Authority. Perform all commissioning activities for all aspects of work provided in Electrical Divisions. Perform all corrective work identified by the Authority.
- .2 Comply with the requirements of sections 20 05 40 and 25 05 15, prepared by Commissioning consultant.

1.48 WARRANTY

- .1 Unless otherwise specified in Divisions 00 and 01, warrant electrical work to be in accordance with Contract Documents and free from defects for a period of one (1) year from date of issue of a Certificate of Substantial Performance of the Work.
- .2 Where equipment includes extended warranty period, e.g., five (5) years, first year of warranty period is to be governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are to be direct from equipment manufacturer and/or supplier to Owner.
- .3 Warranty to include parts, labour, travel costs and living expenses incurred by manufacturer's authorized technician to provide factory authorized on-site service.
- .4 Repair and/or replace any defects that appear in Work within warranty period without additional expense to Owner. Be responsible for costs incurred in making defective work good, including repair or replacement of building finishes, other materials, and damage to other equipment. Ordinary wear and tear and damage caused wilfully or due to carelessness of Owner's staff or agents is exempted.
- .5 Do not include Owner deductible amounts in warranties.

- .6 It is understood that warranties are to commence from time of Substantial Performance of the Work, regardless of what is noted within following Sections of Specification. Be responsible for providing whatever "bridging" or additional extended warranty period is required from time that material is purchased until this time.
- .7 Submit signed and dated copies of extended warranties to consultant which clearly states herein specified requirements.
- .8 Visit building during warranty period with Owner representatives. Owner to organize these visits. At these meetings, Owner representatives are to review performance of systems. If performance is satisfactory, then no further action needs to be taken. If unsatisfactory, then correct deficiencies, as directed by Owner representatives, to satisfaction of Owner's representatives. These site visits to occur:
 - .1 once during first month of building operation.
 - .2 once during third month of building operation.
 - .3 once between fourth and tenth month in a season opposite to first- and third-month visits.
- .9 The following table indicates the warranty period that shall be provided for the following equipment:

EQUIPMENT	ITEMS	WARRANTY
LIGHTING	All types of lighting fixtures including LED lamps, drivers, and other associated components.	5 YEARS
LIGHTING CONTROLS	Lighting controls components including occupancy sensors, power packs, dimming switches, room controllers, control wiring and other associated components	5 YEARS

- .10 The Owner/Board reserves the right to initiate a service contract for all equipment with one of the boards approved certified service companies. This shall not affect any of the above extended warranties provided by the manufacturers.

1.49 EQUIPMENT AND SYSTEM MANUFACTURER'S CERTIFICATION

- .1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for equipment/system manufacturer's authorized representative to visit site to examine installation, and after any required corrective measures have been made, to certify in writing to consultant that equipment/system installation is complete and in accordance with equipment/system manufacturer's instructions.

1.50 EQUIPMENT AND SYSTEM START-UP

- .1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in electrical work Sections in accordance with following requirements:
 - .1 Submit a copy of each equipment/system manufacturer's start-up and verification report sheet to consultant for review and incorporate any comments.

- .2 Under direct on-site supervision and involvement of equipment/system manufacturer's representative, start-up equipment/systems, make any required adjustments, document procedures, leave equipment/systems in proper operating condition, and submit a complete set of start-up and verification documentation sheets signed by manufacturer/supplier and Contractor, to consultant.

1.51 PROJECT CLOSEOUT SUBMITTALS

- .1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following:
 - .1 Operating and Maintenance Manuals.
 - .2 As-built record drawings and associated data.
 - .3 Extended warranties for equipment as specified.
 - .4 Operating test certificates, i.e., Fire alarm verification Certificate.
 - .5 Final commissioning report.
 - .6 Identified keys for equipment and/or panels for which keys are required, and other items required to be submitted.
 - .7 Other data or products specified.

1.52 INSTRUCTIONS TO OWNER

- .1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.
- .2 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.
- .3 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel (for up to 6 people each session), on operation and maintenance procedures of system.
- .4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals during training sessions. Training modules include but are not limited to:
 - .1 Operational Requirements and Criteria – equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations.
 - .2 Troubleshooting – diagnostic instructions, test, and inspection procedures.
 - .3 Documentation – equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like.
 - .4 Maintenance – inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools.
 - .5 Repairs – diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
 - .6 The training sessions shall be scheduled and co-ordinated by the Commissioning Agent. The Commissioning Consultant shall video tape the sessions. Refer to Section 20 05 40 for further requirements.
- .5 Before instructing Owner's designated personnel, submit to consultant for review a preliminary copy of training manual and a proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.

- .6 Obtain in writing from consultant a list of Owner's representatives to receive instructions. Submit to Consultant prior to application for a Certificate of Substantial Performance of the Work, a complete list of systems for which instructions were given, stating for each system:
 - .1 Date instructions were given to Owner's staff.
 - .2 Duration of instruction.
 - .3 Names of persons instructed.
 - .4 Other parties present (manufacturer's representative, consultants, etc.).
 - .7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation, and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.
 - .8 Submit to Consultant, copy of electronic version of training materials used to train Owner's designated personnel. Include in operating and maintenance manuals submission.
- 1.53 FINAL INSPECTION
- .1 Submit to Consultant, written request for final inspection of systems. Include written certification that:
 - .1 Deficiencies noted during job inspections have been completed.
 - .2 Field quality control procedures have been completed.
 - .3 Systems have been tested and verified, adjusted, and are ready for operation.
 - .4 Maintenance and operating data have been completed and submitted to, reviewed, and accepted by consultant.
 - .5 Tags and nameplates are in place and equipment identifications have been completed.
 - .6 Clean-up is complete.
 - .7 Spare parts and replacement parts specified have been provided and acknowledged by consultant.
 - .8 As built and record drawings have been completed and submitted to, reviewed, and accepted by consultant.
 - .9 Owner's staff has been instructed in operation and maintenance of systems.
 - .10 Commissioning procedures have been completed.
- 1.54 SUB-CONTRACTORS TO THE ELECTRICAL CONTRACTOR
- .1 The Electrical Contractor agrees to employ those sub-contractors proposed in the Electrical Form(s) of Tender and accepted by the Board/Owner at the signing of the Contract with the General Contractor.
 - .1 The Board/Owner may, for reasonable cause object to the use of a proposed Sub-Contractor and consequently, may require the Electrical Contractor to employ one of the other Sub- Contractors or Bidders.
 - .2 If the Board/Owner requires a change from a proposed Sub-Contractor originally proposed by the Electrical Contractor, the Contract Price shall be adjusted by the difference in cost.
 - .3 The Electrical Contractor shall not be required to employ as a Sub-Contractor, a firm to whom he may reasonably object.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA-C22.2 No. 131, Type TECK 90 Cable.
 - .2 CSA-C22.2 No. 51 (latest edition), Armoured Cables.
 - .3 CSA C22.2 No. 38 (latest edition), Thermoset-Insulated Wires and Cables.
 - .4 CSA C22.2 No. 75 (latest edition), Thermoplastic-Insulated Wires and Cables.
 - .5 CSA C22.2 No .0.3 (latest edition), Test Methods for Electrical Wires and Cables.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Low voltage wires and cables up to 4/0 shall, unless otherwise noted, have copper conductors with T90 Nylon, 600-volt insulation.
- .3 Low Voltages wires and cables 250 MCM and larger shall, unless otherwise noted, have copper conductors with RW90 X-Link minus 40 degrees F, 1000-volt insulation.
- .4 Aluminium sheathed feeder cables shall, unless otherwise noted, have a corrugated seamless aluminium sheath, copper conductors, RA90 X-Link minus 40 degrees F, 1000-volt insulation and without P.V.C. jacket.
- .5 M.I.C.C. cables shall have solid copper conductors insulated with magnesium oxide and enclosed in a seamless copper sheath with a protective jacket where required.
- .6 All outdoor and underground wiring shall have copper conductors with RWU-90, X-Link, minus 40 degrees F, 1000-volt insulation.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Wires and cables shall be selected so that their current carrying capacity conforms to the standards of the Authorities having jurisdiction.
- .3 Feeders and branch circuits shall be as indicated on the drawings. Supporting of wires and cables with tie wires, perforated straps, etc., shall not be permitted. Electrical Contractor shall use approved clips.
- .4 Unless otherwise indicated on the drawings no wire smaller than #12 AWG shall be used except for internal wiring of lighting fixtures which can be #14.
- .5 BX90 aluminium sheathed cable, unless otherwise noted, may be used in accessible ceiling space and where concealed only. Install BX cables with anti-short bushings.

- .6 Aluminium sheathed and M.I.C.C. cables shall be installed with horizontal supports at not more than 1220mm intervals and shall be spaced, bonded, and grounded in accordance with the requirements of the Authorities having jurisdiction.
- .7 Aluminium sheathed and M.I.C.C. cables shall be terminated with moisture proof connectors.
- .8 Where single conductor cables enter a ferrous box, provide the required non-ferrous plates. Slotting between the knockouts shall not be accepted.
- .9 Aluminium sheathed and M.I.C.C. cables shall be suitably protected, when installed within 5 feet of the floor and in all locations where they might be subject to mechanical injury.
- .10 Joints in feeder cables shall not be permitted.
- .11 Joints in branch circuit wiring shall only occur where such circuits divide at a junction box and shall be mechanically and electrically sound and shall be securely fastened by means of "Ideal" 600V special service wire nut connectors.
- .12 Conductors shall be colour coded and the colour coding shall be consistent throughout the project.
- .13 Conductors shall be identified with self-sticking wire markers, indicating circuit number at all terminations and joints, at panels, pull boxes, junction boxes, etc.
- .14 Termination lugs for feeder cables shall be compression type.
- .15 All outdoor and underground wiring shall have copper conductors with RWU-90, X-Link, minus 40 degrees F, 1000-volt insulation.
- .16 Wiring terminated in an outlet box for future lighting or power shall have 250mm of slack and each cable shall be terminated in a connector.
- .17 Exposed cable runs shall be installed parallel to, or horizontally on, the walls of the building.
- .18 Loads shall be circuited to provide fully balanced feeders.
- .19 Only lubricants approved by the Authorities having jurisdiction shall be used and they shall be suitable for the type of cables installed.

END OF SECTION

1.1 GENERAL

1.2 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 OESC – Latest Edition.
 - .2 Electrical Safety Authority – Latest Inspection Bulletins.
 - .3 CSA C22.1, Canadian Electrical Code, Part 1 – Latest Edition.
 - .4 CAN/CSA Z32, Electrical Safety and Essential Electrical Systems in Health Care Facilities, where applicable.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The grounding equipment shall be in accordance with CSA C22.2 and the copper grounding conductors in accordance with ASA G7.1.
- .3 Provide non corroding accessories necessary for the grounding system.
- .4 Building ground system to consist of a grid of copper welded ground rods (minimum 4' to 10' (1.2m to 3m) long spaced minimum of 10' (3m) apart, interconnected with bare minimum No. 3/0 AWG copper loop. Ground rods shall be driven sufficiently to contact permanent water table. Provide minimum No. 3/0 AWG copper ground loop inside electrical room and vaults for grounding of equipment enclosures and connect to ground grid. Connect building water service pipes (both street and building sides), gas service pipes and sprinkler system pipes, supply and return hot water heating pipes to ground system with minimum No. 3/0 AWG copper ground conductor in conduit. Perform resistivity test on soil to determine exact quantity of rods (minimum of 4).
- .5 All buried ground connections shall be Thermit welded type.
- .6 Provide one (1) No. 3/0 AWG insulated green copper ground conductor in conduit from the main building ground to the main Telephone/LAN Room. Provide a minimum 24" (600mm) long x 2" (50mm) high x 3/8" (10mm) thick copper ground bus and install on wall with standoff isolators and connect to 3/0 cable. Ground bus to have eight drilled taps. Provide one (1) #6 AWG green ground conductor in conduit from this ground bus and extend to each satellite LAN Room and coil for future connection to computer cable termination rack.
- .7 Where cable trays are used for the data cabling pathways, ensure that they are grounded and bonded in accordance with the Ontario Electrical Safety Code.
- .8 Continuous rows of fluorescent/LED fixtures shall be equipped with No. 12 bare copper ground wire for the full length of fixture row.
- .9 The accessories shall be as manufactured by Burndy, Erico, Amp or Caldwell.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide complete permanent and continuous, system and equipment grounding systems including, ground rods, conductors, connectors, accessories, to conform to requirements of the Authorities having jurisdiction.
- .3 Install connectors to manufacturer's instructions.
- .4 Protect exposed grounding conductors from mechanical injury.
- .5 All non-current carrying metal parts shall be bonded in accordance with ESA, CSA, and provincial inspection department standards.
- .6 The neutrals of the dry-type transformer shall be connected by a separate copper ground wire to the ground bus in the switchboard.
- .7 A separate copper ground wire to the ground bus in the switchboard shall be provided for each isolation transformer and isolated ground lighting panel.
- .8 Separate copper wire shall be installed in all flexible conduits, in all rigid conduits, in wall or below slab conduits, EMT conduits and all non-metallic conduits.
- .9 Connect the ground bus in the main switchboard to the main ground and incoming water main ahead of the water meter and provide a water meter shunt.
- .10 The grounding system in the main switchboard shall be suitable for use with the ground fault system.
- .11 Install separate grounding/bonding systems for telephone system, fire detection and alarm system, public address system, video surveillance system and intrusion detection system, in accordance with the systems suppliers' requirements.
- .12 Install grounding system for pad mounted transformer in accordance with ESA and Local Hydro requirements.
- .13 All grounding conductors run inside of building, except in electrical and LAN rooms, shall be run in EMT conduit.
- .14 Install separate ground conductor for outdoor lighting standards.
- .15 Install grounding connections to typical equipment included in, but not necessarily limited to following list: Service equipment, transformers, switchgear, duct systems, motor frames, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting etc.
- .16 Install electrode interconnections where metal parts, circuits, or grounding conductors and/or electrodes are in proximity to lightning rod conductors.
- .17 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Owner's Representative and local authority having jurisdiction over installation.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Type 'C', 'D', 'T' and 'E' pull boxes, junction boxes and cabinets shall be made of code gauge steel with corners lapped and welded and shall be painted and identified as noted in this specification.
- .3 Cabinets shall provide proper space for conduits, wires and connections and their size shall be in accordance with the requirements of the Authorities having jurisdiction.
- .4 The trim and cover shall be as required by the service and location.
- .5 Splitters shall be sheet metal enclosure complete with welded corners and formed hinged cover suitable for locking in closed position.
- .6 Splitters main and branch lugs/connection bars shall match the required size and number of incoming and outgoing conductors as indicated on drawings.
- .7 At least three spare terminals shall be provided on each set of lugs in splitters less than 400A.
- .8 The metal cabinets shall be as manufactured by Eaton, Square-D, Siemens, or Hammond.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Pull boxes, junction boxes and cabinets shall be independently supported from the conduit connected to them.
- .3 Pull boxes shall be installed in inconspicuous but accessible locations.
- .4 The cabinets shall be suitable for the installation and location.
- .5 Cabinets shall be mounted with top not higher than 2m above finished floor.
- .6 All electrical pull boxes above drywall ceilings shall be accessible via a properly sized access door installed directly below the respective pull box in drywall ceilings. Temporary removal of electrical light fixtures will not be considered safe access to above ceiling electrical boxes and shall not be permitted and acceptable.
- .7 Install splitters and mount plumb, true and square to the building lines.

- .8 All pull boxes, cabinets, equipment shall be identified in accordance with Section 26 05 01, Electrical Work General Instructions.
- .9 Identification labels shall be provided indicating system name voltage and phase.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.1, Canadian Electrical Code, Part 1.
 - .2 OESC – Latest Edition.
 - .3 Electrical Safety Authority – Latest Inspection Bulletins.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Size boxes in accordance with latest edition of OESC and/or CSA C22.1.
- .3 102 mm square or larger outlet boxes shall be provided as required for special devices.
- .4 Blank cover plates shall be provided for all outlet boxes without wiring devices.
- .5 347 V outlet boxes shall be provided for 347 V switching devices.
- .6 Barriers shall be provided for outlet boxes where more than one system are grouped.
- .7 Outlet boxes used with rigid steel conduit shall be 'FS' or 'FD' Feraloy condulets.
- .8 Outlet boxes used with EMT conduit shall be electro-galvanized and made of code gauge steel except when they are surface mounted on walls and then they shall be 'FS' or 'FD' Feraloy condulets.
- .9 Outlet boxes installed outside the building shall be weatherproof type, with neoprene gasket and cast cover.
- .10 Electro-galvanized steel masonry single and multi-gang boxes shall be provided for devices flush mounted in exposed block walls.
- .11 Electro-galvanized sheet steel concrete type boxes shall be provided for flush mount in concrete with matching extension and plaster rings as required.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 All outlet boxes shall be supported independently of connecting conduits.
- .3 Outlet boxes shall have adequate knockouts, but only those knockouts actually required shall be opened.

- .4 Outlet boxes shall be securely fastened to the surface on which they are mounted. If the boxes are not mounted on a surface, then adequate and independent supports must be provided.
- .5 Outlet boxes shall be provided for each surface mounted lighting fixture.
- .6 Outlet boxes shall be provided for each recessed mounted lighting fixture.
- .7 Multi-gang outlet boxes with single cover plate shall be used where switches are grouped.
- .8 Unused opened knockouts shall be closed with steel knockout plugs.
- .9 Correct size of openings shall be provided in boxes for conduit, mineral insulated and armoured cable connections. Installation of reducing washers will not be acceptable and allowed.
- .10 All electrical outlet boxes above drywall ceilings shall be accessible via a properly sized access door installed directly below the box in drywall ceilings. Temporary removal of electrical light fixtures will not be considered safe access to above ceiling electrical boxes and shall not be permitted and acceptable.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA-C22.2 No. 62 (latest edition), Surface Raceway System.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Supply and install a surface raceway system. The raceway is to be wall mounted or otherwise supported as indicated. It is to be used as a flexible wiring system and for the installation of receptacle outlets and computer in heavily serviced areas, as shown on the drawings.
- .3 The raceway is to be two channels with removable cover to provide access to wiring and to permit the easy addition or alteration of circuits and devices at any time. Finish Colour to be selected by the Architect.
- .4 Multi-channel raceway is to be provided for power circuits and computer wiring as indicated.
- .5 The system shall be suitable for 120/208V, 3 phase, 4 wire distribution.
- .6 The system shall be Panduit Pan-Way Type T-70 non-metallic multi-channel raceway for locations as shown on Drawings.
- .7 Provide all fittings and covers necessary for the installation. Fittings and covers shall be tampered resistant to prevent unauthorized access to the wiring. This shall include but not limited to the following items:
 - .1 Raceway cover
 - .2 Mounting bracket
 - .3 Connector clip
 - .4 End cap
 - .5 Inside corner base
 - .6 Outside corner base
 - .7 Device bracket for standard data/communication and electrical devices
 - .8 Cover plates for standard data/communication and electrical outlets
 - .9 Duplex receptacle outlets
- .8 Receptacles shall be as specified in Section 26 27 26.
- .9 Computer outlets/ jacks shall be as per specified Section 27 11 19.

.10 Devices shall be flush mounted inside the raceway.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Install the raceway and accessories in a neat and orderly manner.
- .3 Raceways shall be installed horizontally on millwork, walls above counters, baseboards, and backsplash, fixed to drywall or masonry wall surfaces, at mounting heights indicated on the drawings.
- .4 Arrange for the installation of backing in drywall partitions to ensure that the raceway is securely fastened. Horizontal metal studs mounted with sheet metal screws are satisfactory. Fasten raceway base to backing.
- .5 Use continuous lengths for standard lengths. For shorter lengths, field cut to suit. Carefully cut all barriers, covers and bases. Make cuts at right angles. Cut edges to be free from burrs, sharp edges, bends, and other distortions. Use a floor mounted power hacksaw or similar device for cuts.
- .6 In-feeds are to be conduit run concealed in walls and ceiling space.
- .7 Install wire and devices as required.
- .8 Mount Lamacoid nameplates on raceway devices plates, above or below each outlet. Attach with screws. Adhesive fasteners are not acceptable. Engrave with circuit number, including panel designation, and computer outlet number.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 45, Rigid Metal Conduit.
 - .2 CSA C22.2 No. 83, Electrical Metallic Tubing.
 - .3 CSA C22.2 No. 211.2, Rigid PVC (Un-plasticized) Conduit.
 - .4 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .5 CAN/CSA C22.2 No. 227.3, Flexible PVC conduit. Non-metallic Mechanical Protection Tubing (NMPT), a National Standard of Canada.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Submit the following to the Consultant for review:
 - .1 Location drawings for all required sleeves and formed openings in poured concrete or precast concrete construction.
 - .2 Samples of materials and any other items as specified in succeeding Sections of this Division of the Specification.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Rigid metal conduits shall be electro-galvanized and made of standard weight steel pipe and connected with electro-galvanized threaded couplings.
- .3 Electrical metallic tubing shall be a metal raceway which has a wall thinner than that of rigid metal conduit and an outside diameter sufficiently different from that of rigid metal conduit to render it impracticable for anyone to thread it with a standard pipe thread.
- .4 Rigid PVC conduits shall be a rigid non-metallic conduit of un-plasticized polyvinyl chloride.
- .5 Rigid Type I shall be similar to rigid PVC duct, Type EB1, to CSA Standard B196.1 requiring encasement in concrete.
- .6 Rigid Type II shall be similar to Type I except of heavier construction and suitable for direct burial.
- .7 Flexible conduits shall be liquid-tight flexible metal conduit.
- .8 Rigid metal conduits entering boxes in dry locations shall be secured with galvanized steel locknuts and nylon insulated steel bushings.
- .9 Rigid metal conduits entering boxes in wet locations shall be secured with steel bullet hub connectors, nylon insulated with neoprene 'O' ring.

- .10 Connectors for EMT surface mounted conduit shall be steel, set screw and nylon insulated.
- .11 Connectors for EMT conduit in concrete shall be steel, raintight, concrete tight and nylon insulated.
- .12 Couplings for EMT conduit surface mounted shall be steel set screw type.
- .13 Couplings for EMT conduit in concrete shall be steel, rain tight and concrete tight.
- .14 Connectors for flexible conduit shall be steel, liquid-tight, nylon insulated with neoprene 'O' ring.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Install all conduit, conduit fittings and accessories in accordance with the latest edition of the Canadian Electrical Code in a manner that does not alter, change, or violate any part of the installed system components or the CSA/UL certification of these components.
- .3 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .4 Raceways shall be as shown on the Drawings and as detailed in the Specification.
- .5 The size of conduit shall be in accordance with the requirements of the Authorities having jurisdiction.
- .6 All conduits inside the building shall, unless otherwise noted, be electrical metallic tubing.
- .7 Unless otherwise noted branch circuit conduits shall be concealed in wall and ceilings or exposed in unfinished areas and shall not be installed below or in any concrete slab unless otherwise approved by the owner/consultant. Where it is noted that branch circuit conduits can be installed in a concrete slab that is not on grade the conduit shall be electrical metallic tubing with a copper ground wire.
- .8 Conduits exposed to the weather, in wet locations, subject to mechanical injury or in any hazardous locations, shall be rigid metal conduit.
- .9 Conduits in plenums shall be rigid metal conduit.
- .10 Telephone zone conduits shall be PVC conduit when installed in concrete and EMT in other locations.
- .11 Telephone distribution conduits shall be rigid P.V.C. conduit when installed in concrete or underground and EMT conduit in other locations.
- .12 Motor feeder drops shall be in rigid conduit with a maximum 910mm of flexible metal conduit. Rigid conduit for the drops shall start at least 910mm ahead of the actual bend and have two additional clips over normal requirements. The minimum conduit size for the drops shall be 19mm.
- .13 Liquid tight flexible metal conduit shall be used for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .14 Explosion proof flexible connection shall be used for connection to explosion proof motors.
- .15 Conduit sealing fittings shall be installed complete with compound in hazardous areas.

- .16 Conduits in finished areas shall be concealed and those in unfinished areas shall be surface mounted unless otherwise noted.
- .17 Feeder conduits shall not be installed in or below any concrete slab, unless approved by the Consultant.
- .18 Conduits shall be installed so that the conductors can be drawn in without strain or injury.
- .19 Expansion fittings shall be installed in conduits crossing expansion joints.
- .20 Conduits shall be installed to provide for expansion and expansion fittings shall be provided where required.
- .21 Conduits shall not be installed within 75mm of water, sprinkler, drain or waste piping.
- .22 Exposed conduits shall run parallel to or horizontally on the walls of the building.
- .23 Conduit ends shall be carefully plugged during construction with steel capped bushings.
- .24 The use of running threads shall not be permitted. Ericson couplings shall be used where required.
- .25 Conduits shall not pass-through structural members without the approval of the Consultants.
- .26 Powder activated fastenings can only be used if approved by the Consultant.
- .27 Conduits shall be fastened with approved clips. Supporting of conduits with tie wires, perforated straps, etc. shall not be permitted. If a conduit rests on structural steel, etc., this will not be considered as a support. Provide proper supports, hangers, etc. and supports conduits from the top of structural beams/joists.
- .28 Conduits shall not be attached or suspended from the metal deck unless approved by the Consultant.
- .29 Conduit supports shall be spaced in accordance with the requirements of the Authorities having jurisdiction.
- .30 An adequate number and size of pull boxes shall be installed where required in all conduits runs to facilitate the installation of the conductors.
- .31 Fish wires shall be installed in all empty conduits, including telephone conduits.
- .32 Excessive lengths of flexible conduit shall not be accepted. Maximum 10'-0" of length will be acceptable.
- .33 Proper metallic contacts shall be made between conduit, boxes, etc.
- .34 Maximum size of conduit on which ground bushings can be used is 32mm.
- .35 A separate ground wire shall be installed in all flexible conduits, EMT conduits, underground conduits, in wall or below a concrete slab, underground parking lot lighting and in all non-metallic conduits or ducts.
- .36 Installation of conduit in oversize knockouts shall not be accepted.
- .37 Joints in conduits installed underground, in concrete slab on grade or in a concrete duct bank shall be pitched on the outside and made completely watertight.
- .38 Minimum concrete thickness over a conduit in a concrete slab where applicable shall be 50mm.

- .39 Spare or unused conduits that terminate in an enclosure shall be capped.
- .40 Conduits passing through concrete and/or masonry floors, walls, roof and any other such construction shall be provided with sleeves.
- .41 Electrical conduit roof flashing shall be similar to National Roofing supply product code# ECP-PVCH (electrical conduit post PVCH), Gooseneck S.S.A ARPGN2 (2")/ ARPGN3 (3").
- .42 Protect conduits from damage where they stub out of concrete. Use rigid steel conduit for stub-up and adapt to in floor rigid PVC conduit.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.
- .3 Project specific design values shall be used for determining seismic and wind design forces based on the information on the structural drawings. The values below are provided for reference only for the purpose of coordinating with suppliers and other trades. If a conflict exists between these values and the structural drawings, the values on the structural drawings will prevail. Where project documents do not provide values necessary to determine design forces, the Delegated Design Engineer may use values substantiated through the governing building code(s) or the authority having jurisdiction and subject to review and approval by the Engineer of Record.
 - .1 Risk Category: [I, II, III, or IV]
 - .2 Seismic Design Category: [A, B, C, D, E, or F]
 - .3 Short-period Spectral Response Acceleration parameter (SDS): [#.##g]
 - .4 Basic wind speed: [####mph (####kph)]
- .4 All vibration isolation and restraint products and associated engineering work shall be provided by one supplying manufacturer. Preferred manufacturer is Vibro-Acoustics. Alternate manufacturers must request and obtain written approval by the Engineer of Record for substitutions.
- .5 Isolation and restraint products shall be tested or analysed for performance as appropriate and reports shall be made available to the Engineer of Record upon request.
- .6 All work to determine seismic and wind restraints shall be done by or under the direct supervision of a qualified professional engineer in responsible charge of the work acting as the Delegated Design Engineer. This Delegated Design Engineer must hold an active license in the province of the project.

1.2 REFERENCES

- .1 Ontario Building Code, latest edition
- .2 CAN/CSA C22.2 NO.250.0, Luminaires, latest edition.
- .3 CAN/CSA-G40.21, Structural Quality Steels, latest edition.

1.3 SUBMITTALS

- .1 Submit shop drawings include:
 - .1 Design load and calculation.
 - .2 Details of design criteria
 - .3 Identification of location where electrical equipment to be provided with seismic bracing.
 - .4 Installation procedures.
 - .5 Testing and certification
- .2 Submittal shall be designed and stamped by a professional Engineer, licensed to practice specializing in design of seismic force restraint system.

2. Products

2.1 GENERAL

- .1 The seismic restraint manufacturer shall be responsible for the selection of the attachment hardware as required to attach snubbers/restraints to both the equipment and supporting structure on vibration isolated equipment, or to directly attach equipment to the building structure for non-isolated equipment.
- .2 The contractor shall furnish, to the seismic restraint manufacturer, a complete set of approved shop drawings of all equipment that is to be restrained, from which the selection and design of seismic restraint devices and/or attachment hardware will be completed. The shop drawings furnished shall include, at a minimum, basic equipment layout, length and width dimensions, and installed operating weights of the equipment to be restrained.
- .3 All electrical equipment (lighting fixture, panel, transformer, conduits, cable trays, etc.) are to be restrained to meet code requirements. At a minimum, the seismic restraint manufacturer shall provide documentation on maximum restraint spacing for various restraint sizes and anchors, as well as "worst case" reaction loads for each restraint and/or anchor size
- .4 The contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly dowelled to the building structure, so as to withstand calculated seismic forces. In addition, the size & thickness of the housekeeping pad is to be coordinated with the seismic restraint manufacturer to ensure that adequate edge distances & embedment depths exist in order to obtain the desired equipment anchor capacities.
- .5 Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi.
- .6 Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment).
- .7 The acceptable manufacture for Seismic Force Restraint System shall be:
 - .1 Kinetics noise Control Inc.
 - .2 Eaton
 - .3 Vibro-AcousticsOr approved equal meets specification.

3. Execution

3.1 COORDINATION AND EXECUTION

- .1 Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 3,000 psi or as specified by the project engineer. Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Pads and piers must be adequately doweled in to structural slab.
- .2 Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors. Refer seismic restraint manufacturer's written instructions.
- .3 Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment). Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.

- .4 Isolated and restrained equipment and conduit located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure will not be acceptable.
- .5 Attach piping to the trapeze per seismic restraint manufacturer's design. Install cables so they do not bend across sharp edges of adjacent equipment or building structures
- .6 Do not brace or support equipment to separate portions of the structure that may act differently in response to an earthquake. For example, do not connect a Transverse restraint to a wall and then a Longitudinal restraint to either a floor/ceiling/roof at the same braced location.
- .7 Install vertical braces to stiffen hanger rods and prevent buckling per seismic restraint manufacturer's design. Clamp vertical brace to hanger rods. Requirements apply equally to hanging equipment. Do not weld vertical braces to hanger rods.

3.2 SEISMIC RESTRAINT APPLICATION:

.1 General

- .1 All equipment, conduits, cable trays shall be restrained to resist seismic forces per the applicable building code(s) as a minimum; listed herein. Additional requirements specified herein are included specifically for this project; as needed basis.
- .2 Install seismic restraint devices per the manufacturer's submittals. Any deviation from the manufacturer's instructions shall be reviewed and approved by the manufacturer.
- .3 Attachment to structure for suspended equipment, pipe and duct: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- .4 Provide hanger rod stiffeners where indicated or as required to prevent buckling of rods due to seismic forces.
- .5 Where rigid restraints are used on equipment, cable tray, the support rods for the equipment, ductwork or piping at restraint locations must be supported by anchors rated for seismic use.
- .6 Ensure housekeeping pads have adequate space to mount equipment and seismic restraint devices and shall also be large enough and thick enough to ensure adequate edge distance and embedment depth for restraint anchor bolts to avoid housekeeping pad breakout failure.

.2 Concrete Anchor Bolts:

- .1 Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre- or post-tensioned tendons, electrical and telecommunications conduit.
- .2 Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength
- .3 Mechanical Anchors: Protect threads from damage during anchor installation.
- .4 Adhesive Anchors: Clean holes to remove loose material and drilling dust per manufactures instructions prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
- .5 Set anchors to manufacturer's recommended torque, using a torque wrench.

.3 Equipment Restraints:

- .1 Install fasteners, straps and brackets as required to secure the equipment.
- .2 Provide seismic restrains for all electrical equipment.
- .3 The electrical contractor are to provide the weight per unit length for cable trays & conduits.
- .4 Longitudinal restraints for single conduit supports shall be attached rigidly to the pipe, not to the pipe/conduit hanger.
- .5 For supports with multiple conduits (trapezes), secure conduits to trapeze member with clamps approved for application.
- .6 Where conduit, bus ducts, cable trays sizes reduce below required dimensions, the final restraint shall be installed at the transition location.
- .7 Adjust restraint cables so that they are not visibly slack. Cable not to support weight during normal operation.
- .8 Seismic systems are to be compatible with requirements for anchoring and guiding of systems.

3.3 INSPECTION & CERTIFICATION:

- .1 The contractor shall notify the local representative of the seismic restraint materials manufacturer prior to installing any seismic restraint devices. The contractor shall seek the representative's guidance in any installation procedures with which he/she is unfamiliar.
- .2 The contractor shall notify the local representative of the seismic restraint materials manufacturer mid-way through the listed project if they require an inspection of any and all vibration and seismic restraint devices already installed. A written report of any installation errors, improperly selected devices, or other fault in the system which could affect the performance of the system shall be documented and the contractor shall perform all steps that are required from this written report to properly complete the vibration and seismic restraint work as per the specifications.
- .3 Upon completion of the installation, arrange for an independent 3rd party registered design professional, upon request, is to visit the site to verify the proper installation of all seismic restraint devices herein specified. The local representative of the vibration manufacturer shall, at the contractor's request, be present as well to support the independent professional in the inspection of the completed system. A written report citing any installation errors, improperly selected devices, or other fault in the system which could affect the performance of the system should be generated by the 3rd party professional. Also, the local representative shall verify that isolators are adjusted, with spring's perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.
- .4 The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Access panels for walls and ceiling shall be of the flush type with concealed flanges constructed from 12 gauge minimum bonderized steel and shall be complete with anchor straps, rust resistant concealed hinges and positive locking, self-opening screwdriver operated lock. Coordinate with Division 23.
- .3 Access panels in tiled walls shall be stainless steel with recessed door panel to accept wall finish and shall be of a size to suit tile pattern.
- .4 Access panels installed in fire rated walls, partitions or ceilings shall have a fire resistance rating equal to the materials in which they are installed.
- .5 Access panels shall be as manufactured by LeHage, SMS, Pedlar or approved equal.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 All parts of the installation including, but not limited to, pull-in, junction and outlet boxes, cabinets, gutters, etc. shall be accessible.
- .3 Supply access panels as required to provide complete access to all equipment and connections. The access panels shall be installed by other Sections of the specification.
- .4 Provide drawings showing size, type and location of all access panels and submit for review by the Consultant.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Electric supplementary heaters and controls shall, unless otherwise noted, be supplied by Division 23.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Install all electric heaters and remote electric thermostats supplied by Division 23.
- .3 Electric duct heaters shall be installed by another Division of Specification.
- .4 Provide all conduit, wiring, etc. and connect to the electric heaters, electric duct heaters and remote electric thermostats to provide a complete Electric Heating System.
- .5 Install filler pieces as shown on the drawings between baseboard heaters to form a continuous length.
- .6 All L.V. control wiring shall be by Division 23.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 This Section is for provisions for Building Automation System only.
- .3 Divisions 23 will supply and install a Computerized Building Automation System complete with the distribution boxes, control sequencing and all interfacing.
- .4 Division 26 shall provide individual lighting relays and/or contactors for each individual circuit and associated relay boxes and connect to load side of relays, as shown on the drawings. All control wiring by Division 23.
- .5 Contactors used in conjunction with building automation system shall be electrically operated, electrically held type. Refer to Section 26 29 01.
- .6 Coordinate all work with Division 23.

Execution: NOT USED

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of disconnect switch, type, quantity, voltage, ampacity, and dimension etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The hand dryers shall be World Dryer; SLIMdri, surface mounted ADA compliant with universal brush type motor, die cast aluminum finished with white cover finish (#L-974) and 120v input voltage.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide backboxes as required complete with conduit and wiring and connect to circuits as shown on the drawings. Coordinate all associated work with Architectural drawings.
- .3 Hand dryers shall be installed in accordance with manufacturer's recommendations.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Submit the following to the Consultant for review:
 - .1 Drawings to include electrical detail of lighting control devices including occupancy sensor complete with associated power pack etc., quantity, control schematic wiring diagram and coverage area etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Provide lighting control device(s) including occupancy sensors, room controllers, daylight sensors, dimmers, etc. as specified on the drawings:
 - .1 Provide associated power and relay packs.
 - .2 Provide all associated mounting accessories.
- .3 Electrical Contractor shall include in tender price for installation, testing, time adjustment, functional testing and commissioning of occupancy sensors, room controllers, daylight sensors, and programming of Auto-On sequence of all lighting control devices for light fixtures on a room-by-room basis in entire building by manufacturer. Submit verification/commissioning report after completion of work.
- .4 Lighting Control Devices Commissioning:
 - .1 Functional testing: Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions. Where occupancy sensors, time switches, programmable schedule controls, or photo sensors are installed, the following procedures shall be performed.

Occupancy sensors:

- .1 Certify that the sensor has been located and aimed in accordance with manufacturer recommendations.
- .2 For each sensor to be tested, verify the following:
 - .1 Status indicator (as applicable) operates correctly.
 - .2 Controlled lights turn 'off' or down to the permitted level within the required time.
 - .3 For auto-on occupancy sensors, the lights turn 'on' to the permitted level when someone enters the space.
 - .4 For manual-on sensors, the lights turn 'on' only when manually activated.
 - .5 The lights are not incorrectly turned 'on' by movement in nearby areas or by HVAC operation.

- .6 Simulate occupied condition. Verify and document the following:
 - .1 All lights can be turned 'on' and 'off' by their respective area control switch.
 - .2 The switch only operates lighting in the enclosed space in which the switch is located.
 - .7 Simulate unoccupied condition. Verify and document the following:
 - .1 All non-exempt lighting turns 'off'.
 - .2 Manual override switch (where applicable) allows only the lights in enclosed space where the override switch is located to turn 'on' or remain 'on' until the next scheduled shut off occurs.
 - .8 Daylight controls
 - .1 All control devices (photocontrols) have been properly located, field-calibrated, and set for appropriate setpoints and threshold light levels.
 - .2 Daylight controlled lighting loads adjust to appropriate light levels in response to available daylight.
 - .3 The location where calibration adjustments are made is readily accessible only to authorized personnel.
 - .2 Functional testing report/documentation shall certify that the installed lighting control of each respective space in entire building meets all requirements as specified in the contract documents.
 - .5 All occupancy sensors must be installed as per manufacturer's recommended location and wiring diagram.
 - .6 Occupancy sensors time delay settings must be adjusted and co-ordinated to suit the Owner requirements.
 - .7 Cooper lighting, Current lighting, Acuity (Sensor Switch/ nLight) and Wattstopper shall be considered equivalent for lighting control system.
3. Execution
- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
 - .2 Install all lighting control devices as shown on electrical drawings. Provide all components to suit.
 - .3 Exact location of occupancy sensors shall be co-ordinated on site and shall comply with the manufacturer's recommendations.
 - .4 Occupancy sensors shall turn off the corresponding light fixture when light switches are in the "On" position and the space is not occupied.
 - .5 Adjust occupancy detection sensitivity to match the level of activity for each space.
 - .6 Install power packs and associated relays to suit the number of circuits in the respective spaces. Installation shall comply with the manufacturer's recommendations. Coordinate all work with manufacturer.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 29, Panel boards and enclosed Panel boards.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of panel board, branch breaker type, quantity, ampacity, KAIC rating and enclosure dimensions etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Panel boards shall be of the size, capacity and type as shown on the drawings. Series or integrated ratings shall not be an acceptable method of achieving specified interrupting levels for breakers, panels, or electrical equipment in general. Where an interrupting rating is specified, it shall be on a breaker, panel, or switchboard. Each breaker associated shall be fully rated to interrupt that magnitude of current. If there is a conflict between drawings and specifications, the higher rated value associated with that particular equipment shall be deemed to be correct.
- .3 Panel boards shall be of the sprinkler-proof, dead front type enclosed in code gauge steel equipped with door, gasket, lock, and directory and shall be suitable for surface or flush mounting as required.
- .4 Bussing in each panel shall be copper and shall extend the full length of the panel. Multi-section panels shall have full capacity rated horizontal bussing between each section.
- .5 Breakers shall be ambient compensated type, calibrated at 40 degrees C and be of the bolt-on type. Multi-pole breakers shall have common trip.
- .6 Panel boards for use on 240-volt or 208-volt system shall, unless otherwise noted be of the "NQ" panel or I-line panel as indicated on drawings.
- .7 Panel boards for use on 600-volt system shall, unless otherwise noted be of the "NF" panel as indicated on drawings.
- .8 Panels, including tubs, shall have two coats of primer paint and two coats of ASA 61 grey paint.
- .9 Panel boards shall be of the same manufacturer as the switchboard.
- .10 All circuit breakers shall be installed in panel boards before shipment.
- .11 Panel boards shall be provided with mains, number of circuits, KAIC rating and branch circuit breaker sizes as indicated in contract documents.

- .12 Lock-on devices shall be provided for fire alarm, emergency and exit lighting circuits and other circuits as indicated in contract documents.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Locate panel boards where indicated; and mount securely and plumb true and square to adjoining surfaces.
- .3 Panels are to be mounted so that the top of the panels are 1800mm above finished floor.
- .4 Provide 2 - 32mm empty conduits from each flush mounted panel to the ceiling spaces above and below for future installation.
- .5 Provide wire-ways above multi-section panels to avoid cross-wiring.
- .6 Numbering of breakers in multi-panel assemblies shall be consecutive. If necessary, provide narrow Dymomite strips with the required numberings.
- .7 Prior to energizing or commissioning the panels, they shall be fully inspected, tested, checked, and adjusted to include, but not limited to, the following:
 - .1 Grounding.
 - .2 Breaker settings.
 - .3 Breaker operation.
 - .4 Continuity of feeder cables.
 - .5 Phase resistance of feeder cables.
 - .6 Insulation resistance of feeder cables.
 - .7 Proper phasing of incoming and feeder cables.
 - .8 Equal division of load between parallel conductors.
 - .9 Bus torque, supports, clearance, general mechanical conditions, and insulation resistance.
- .8 30% of all breakers in panels shall be equipped with locking devices. These locking devices shall be installed as directed by the Consultant on completion of work and the unused units shall be handed over to the Owners.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA-C22.2 No.55, Special Use Switches.
 - .2 CSA-C22.2 No.111, General-Use Snap Switches.
 - .3 CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices.
 - .4 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Light switches on 120-volt circuits under 1200 watts shall be 15 amp. and above 1800 watts shall be 20 amp.
- .3 Light switches shall be premium specification grade, A.C., Toggle type switches.
- .4 Receptacles shall be of the type shown on the drawings with the standard C.S.A. configurations and shall be specification grade. Hubbell #5262.
- .5 Light switches and receptacles on normal power shall be white unless noted otherwise.
- .6 Isolated ground receptacles shall be orange. Hubbell #1G-5262.
- .7 Wall plates for flush mounted devices shall be multiple gangs' super stainless-steel type 302.
- .8 Wall plates for surface mounted devices in unfinished areas shall be metal covers for F.S. type boxes.
- .9 The weatherproof plates shall be cast aluminium with lift cover for F.S. type boxes.
- .10 For T.V. and computer outlets provide blank cover plates unless work is complete.
- .11 For telephone outlets provide blank cover plates unless work is complete.
- .12 Receptacle mounted on the exterior walls of the building shall be with ground fault protection mounted in an F.S. type box with a Hubbell #5206WO and MX3200 weatherproof in-use cover plate.

- .13 50A/208V 1 phase 3W receptacle, range receptacle Smith & Stone #1-8450 complete with plug and cord set.
- .14 30A, 120/208V receptacle Smith & Stone #1-8430 dryer receptacle complete with plug and cord set.
- .15 Wiring devices shall, unless otherwise noted, be of Pass & Seymour, Hubbell, Leviton, or Cooper manufacture.
- .16 All service receptacles on roof shall be 15/20A combination GFI type receptacles complete with weatherproof in-use cover (Similar to Hubbell Cat. #MX3200).
- .17 Receptacle controlled by occupancy sensor shall be Similar to Hubbell Cat. #BR15C2GRY.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Symbols on drawings show approximate locations. Care shall be taken to locate each device to ensure that it is in the appropriate location to suit the Architectural finishes.
- .3 Mounting heights are referred to finished floor or finished ceiling unless related to benchmark elevations.
- .4 Provide cover plates for flush mounted manual starters.
- .5 Receptacle, telephone, etc. outlets shall, unless otherwise noted, be mounted vertically 400mm above finished floor in the finished areas and 1200mm in all unfinished areas. Thermostats shall be mounted 1400mm, unless otherwise noted.
- .6 Telephone, P.A., etc. wall outlets shall be spaced 100mm from power outlet.
- .7 All wiring devices cover plates shall be labelled using clear adhesive strips with black type identifying, panel and circuit number(s) for each device.
- .8 Single throw switch(es) shall be installed with handle in "UP" position when switch closed.
- .9 Switches shall be installed in gang type outlet box(es) when more than one switch is required in one location.
- .10 Receptacles shall be installed in gang type outlet box(es) when more than one receptacle is required in one location.
- .11 Suitable common cover plates shall be installed where wiring devices are grouped.
- .12 Cover plates meant for flush mount outlet boxes shall not be use for surface mounted outlet boxes.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 248.12, Low Voltage Fuses

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of fuse type, quantity, ampacity, voltage rating and dimension etc.
- .3 Submit fuse performance data characteristics for each fuse type and size. Performance data to include average melting time-current characteristics.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Fuses protecting motor circuits shall be Form I Class 'J' time delay.
- .3 Other fuses up to 600A shall be Form I Class 'J'.
- .4 Other fuses above 600A shall be Form I Class 'L'.
- .5 All fuses shall be of Ferraz, Shawmut or Bussman.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide fuses for the complete electrical installation.
- .3 Supply six (6) spare fuses of each size and type installed.
- .4 Provide in the main electrical room a wall mounted metal cabinet complete with doors and lock, and an adequate quantity of pigeonholes to accommodate the spare fuses.
- .5 To avoid confusion and possible loss the fuses shall not be stored in the cabinets until they are physically counted by the Owner's representative and a written receipt obtained for them. A copy of the receipt shall be included in the manuals.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of disconnect switch, type, quantity, voltage, ampacity, and dimension etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Disconnect switch(es) shall have the operating handle interlocked with the switch cover so that it can only be opened when the switch is in the "Off" position, and the handle cannot be put in the "On" position unless the cover is closed.
- .3 Fused disconnect switch(es) shall have steel reinforced clips and fuses shall be easily removable when the switch is in the "Off" position.
- .4 Switches shall have ample gutter space for top or bottom wiring and shall have fully visible blades when in the "Off" position, quick-make, quick-break mechanism and be horsepower rated.
- .5 Disconnect switch(es) shall be provided with ON-OFF switch position indication on switch enclosure cover.
- .6 Switches used outdoors shall be in a weatherproof enclosure.
- .7 Switches shall have provision for padlocking in the "Off" position and interlock defeat.
- .8 All motors shall be provided with a disconnect switch by this Division unless otherwise noted.
- .9 The disconnect switches shall be as manufactured by Eaton, Siemens, or Square 'D'.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Disconnect switch(es) shall be installed complete with fuses as indicated on drawings and in contract documents.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No.14, Industrial Control Equipment.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of contactor, quantity, ampacity, voltage, control schematic wiring diagram and enclosure dimension etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Contactors controlling panel boards or branch circuits shall be tungsten rated, electrically operated, electrically held of the size and rating specified, complete with control transformer, control circuit fuses, pilot light warning label, NO/NC contacts and On/Off/Auto selector switch.
- .3 Contactors shall be in sprinkler proof enclosure unless otherwise noted.
- .4 The contactors ampere rating shown on the drawings is the minimum continuous enclosed de-rated rating of the contactors. Contactors shall be designed and manufactured in accordance with NEMA Standards.
- .5 Contactors controlling branch circuits shall be mounted above the panel board from which they are fed, unless otherwise noted.
- .6 Contactors shall be of Allen-Bradley, Eaton, Siemens or Square 'D' manufacture.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Field designed and assembled contactor assemblies will not be acceptable.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 International Electrotechnical Commission (IEC).
 - .1 IEC 947-4-1, Part 4: Contactors and Motor-Starters.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The motors shall be provided and adjusted by Division 23, Mechanical.
- .3 The starters shall be supplied by Division 23, Mechanical.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide and connect conduit and power wiring to the motors.
- .3 Conduit and wiring for low voltage thermostats shall, unless otherwise noted, be provided by another Division of the Specification.
- .4 Wiring and conduit for line voltage thermostats shall be by this Division. Coordinate with Division 23, Mechanical drawings.
- .5 Take delivery of and install the starters and provide and connect conduit and power wiring to the starters. Control wiring and conduit shall, unless otherwise noted, be provided by Division 23, Mechanical.
- .6 Fuses for the fused combination magnetic starters shall be supplied and installed by Division 23, Mechanical.
- .7 Prepare schedule of each motor connected which shall include the following:
 - .1 Phase
 - .2 Voltage
 - .3 Horsepower
 - .4 Full load current
 - .5 Motor Purpose
 - .6 Fuse size and type
 - .7 Overload heater size and type
- .8 Submit the motor schedule for review by the Consultant and include the schedule in the manuals.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.
- .3 Refer to section 26 50 10, Lighting Fixtures Schedule

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Light fixtures finish and construction shall meet ULC listings and CSA certifications related to intended installation.
- .3 Light Emitting Diodes (LED) shall comply with the following:
 - .1 Light emitting diodes shall be manufactured by "Cree" or equal.
 - .2 Junction temperature at 25°C ambient shall not exceed 60°-70°C.
 - .3 LED light fixture(s) shall follow LM-79 and LM-80 Standards. Luminaire photometric shall be performed by an independent company.
 - .4 Lumens per watt output (LPW) shall be not less than 100 LPW.
 - .5 The lifetime rating of driver, LEDs and all electrical components of complete fixture shall be 60,000 hours (minimum) at full load.
 - .6 Colour temperature shall range from 3500K to 5100k as called for in the Lighting Fixtures Schedule.
 - .7 All electrical components shall have a 5-year replacement (parts and labour) warranty.
 - .8 LED light fixture(s) shall be DLC certified.
 - .9 LED light fixture(s) shall be complete with 0-10V dimming driver.
- .4 The louvres for light coves in washrooms and display cases and where shown shall be 1/2"x1/2"x1/2" (13x13x13mm) continuous aluminium and shall be of American Louvre manufacture.
- .5 Lenses shall be acrylic (minimum of 0.175mm) with a maximum flame spread rating of 250 and smoke development classification of 600 and shall be of KSH, American Louvre or Orcons manufacture.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Remove from the site all empty cartons, crates, etc. in which the fixtures and associated components are delivered.
- .3 Install lighting fixtures at locations as indicated on drawings and in contract documents.
- .4 The chain supports required for mounting and installation of recessed lighting fixtures shall be supplied and installed by this Division. The supports shall be attached to the structure with minimum 2 supports per fixture. The ceiling system shall not be used as a supporting means. Prior to installation of lighting fixtures, Electrical Contractor shall coordinate with consultant and get approval.

- .5 Surface mounted fixtures shall be independently supported from the structure above.
- .6 Fixtures connected to the circuits exceeding 150 volts to ground shall be mounted at least 8 feet above floor level.
- .7 Fixtures mounted in continuous rows shall be equipped with aligning clips to form straight uninterrupted line.
- .8 Align light fixtures mounted individually parallel or perpendicular to building grid lines.
- .9 The location of lighting fixtures in Service Areas, Electrical and Mechanical Rooms, etc. shall be determined after the equipment is installed.
- .10 Refer to the Architectural reflected ceiling drawings for the exact location of the lighting fixtures.
- .11 Cooperate with the other Divisions to establish proper clearances from sprinkler heads, diffusers, ducts, etc.
- .12 Surface mounted fixtures shall have minimum clearance of 2'-0" (600mm) from adjacent sprinkler heads.
- .13 Provide additional supports, hangers etc. required to support fixtures mounted under ductwork and the fixture supports shall not be attached to either the ductwork or the ductwork supports.
- .14 Provide and connect all branch circuit conduit and wiring to the signs (if required).
- .15 Angles required for support of 1/2"x1/2"x1/2" (13x13x13mm) louvre shall be by Ceiling Division.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 141 (latest edition), Unit Equipment for Emergency Lighting.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Drawings to include electrical detail of system components, mounting method, source of power and special attachment etc.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 Battery Cabinet shall be suitable for direct or shelf mounting to wall and complete with knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .3 The complete system shall have a one-year unconditional guarantee, and a 5-year pro-rata guarantee on workmanship and parts and 10 years pro-rata on batteries.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Install units where; shown on the drawings and provide all necessary mounting platforms and mounting hardware.
- .3 Electrical Contractor shall provide report with on-site readings to show lighting levels in all areas with emergency lighting fixtures.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical.
- .2 The existing P.A. system shall remain and shall be operational at all times.
- .3 Provide associated outlet boxes, back boxes, P.A. system wiring, P.A. system devices, testing, conduits terminated in corridor and provide extension to the existing system as shown on drawings and indicated in specification and in accordance with manufacturer recommendation. Provide all associated components to suit.
- .4 In classrooms, and washrooms/ Universal/ B.F. washrooms speakers shall be two-way and shall be an 8" dual cone design with a minimum frequency response of 30Hz-18kHz. It shall have a minimum voice coil diameter of 3/4", a 5-ounce magnet and be capable of handling 10 watts of program power. Any system requiring a line matching transformer for each staff station location will use a transformer of such quality that a minimum frequency response of 60Hz-12kHz will be provided.
- .5 All new P.A. system devices i.e., P.A. system speaker(s), call button, handset, horn(s) etc. shall match existing and shall be compatible with existing P.A. system panel.
- .6 Relocate existing P.A. system devices as shown on drawings. Extend associated conduit, wiring and adjust all components to suit.
- .7 New P.A. system wiring shall be plenum rate FT-6 type, 24 AWG, four (4) twisted pair to match existing wiring. Install new wiring in new outlet/back boxes, conduits, and "free run" in corridor ceiling space. Provide associated "J-hooks" as required for proper support.
- .8 Install wiring in new conduits/outlet boxes.
- .9 Terminate new wiring in existing P.A. system panel.
- .10 Terminate all conduits in corridor ceiling.
- .11 The fish wire shall be installed in each conduit.
- .12 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.
- .13 Installations of equipment and wiring shall be done in accordance with manufacturer's recommendations and school board requirements.
- .14 After completion of the system provides verification report by system manufacturer/installer.
- .15 P.A. system installer shall be "Surefoot" or any other Simplex/ Valcom system certified installer approved by the School Board.

3. Execution

- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
- .2 Provide conduits, outlet boxes and other materials as required and/or shown on the drawings for installation of P.A. system devices and equipment.
- .3 Conduits for P.A. devices shall be terminated as shown on the drawings. Coordinate all work with the P.A. system supplier/installer.
- .4 The installation shall be in accordance with the Board's requirements.
- .5 All distribution conduits shall be complete with slip sleeves to permit the installation of the distribution cables.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524 - Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S525 - Audible Signal Device for Fire Alarm Systems.
 - .3 CAN/ULC-S526 - Visual Signal Devices for Fire Alarm Systems.
 - .4 CAN/ULC-S527 - Control Units.
 - .5 CAN/ULC-S528 - Manual Pull Stations for Fire Alarm Systems.
 - .6 CAN/ULC-S529 - Smoke Detectors for Fire Alarm Systems.
 - .7 CAN/ULC-S530 - Heat Actuated Fire Detectors for Fire Alarm Systems.
 - .8 CAN/ULC-S531 - Standard for Smoke Alarms.
 - .9 CAN/ULC-S536-S537 - Burglar and Fire Alarm Systems and Components.
 - .10 CAN/ULC-S548 - Water flow Indicators for Fire Protective Signalling Systems.
- .2 National Fire Protection Agency (NFPA)
 - .1 NFPA 72 - National Fire Alarm Code.
 - .2 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

- .1 Submit shop drawings for all products specified in Part 2.
- .2 Submit manufacturer's printed product literature, specifications and data sheets as required and specified in specification.
- .3 Submit equipment and zoning layout complete with wiring diagram.

2. Products

- .1 The fire alarm system is existing and must be operational at all times. All new devices must match existing.
- .2 Provide extension to the existing system fire alarm system as shown complete with F.A. devices and all necessary alarm, supervisory, and shut-down, modules as required for proper installation and operation. F.A. panel shall support existing and new zones. Adjust all components to suit.
- .3 All new devices shall match existing F.A. manufacturer (F.A. pull stations, smoke, and heat detectors, F.A. speakers/ horns, duct detectors, etc.).
- .4 Where indicated on the drawings; remove or relocate existing fire alarm speaker/strobe, F.A. pull stations, F.A. detectors etc. as shown.
- .5 Before re-installation, the F.A. speakers, F.A. pull stations or F.A. detectors shall be cleaned, tested, and restored to a sound and operating condition. Coordinate with drawings.
- .6 Provide new F.A. devices i.e.: F.A. speakers/ horns, pull stations, heat and smoke detectors, duct detectors, etc. as shown on the drawings.

- .7 The existing fire alarm control panel shall be modified/expanded to suit F.A. zones as shown on the drawings. Adjust and add all components to suit.
 - .8 The existing F.A. graphic shall be replaced with new multi-colour passive graphic to suit existing and new F.A. zones as required.
 - .9 Existing F.A. annunciator(s) shall be modified to suit existing and new F.A. zones as required.
 - .10 Combustion detectors shall operate on the ionization principle and shall be activated by the presence of combustion products. The detector shall be listed by Underwriters' Laboratories of Canada. The detector shall be a plug-in unit containing two ionization chambers, an amplifier-switching circuit and indicator lamp. The unit shall contain no moving parts. One chamber shall be for detection and the second chamber shall function as a reference, to stabilize the detector for changes in temperature, humidity, and pressure. It shall be possible to electrically check the detector's sensitivity and re-adjust the detector's sensitivity as required. The detector shall have incorporated a pilot light.
 - .11 The duct detectors shall be the same as the area detectors but shall include a duct mounting assembly, sampling tubes and remote indicating unit.
 - .12 End-of-line resistors shall be provided by this Division for the complete system.
3. Execution
- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
 - .2 The equipment shall be installed strictly in accordance with the manufacturer's requirements and recommendations and the requirements of the Authorities having jurisdiction.
 - .1 Canadian Electrical Code.
 - .2 Canadian, Provincial and Local Building codes.
 - .3 Local Authorities Having Jurisdiction.
 - .4 Underwriters Laboratories Canada Inc.
 - .5 ULC, BSA.
 - .3 Install wiring to conform with the requirements of the Canadian Electrical Code. Size wiring in accordance with Class 2 requirements, except for A.C. Signal Circuits where the wiring shall be sized in accordance with Class 1 requirements but be protected from mechanical injury or other injurious conditions such as moisture, excessive heat, or corrosive action in conduit. Connect wiring to the screw terminals in the devices.
 - .4 Install fire alarm systems in accordance with the latest Standards as identified in Section 1.2.1 above.
 - .5 Install end-of-line resistors in a separate outlet box with grille.
 - .6 Provide a complete system of relays for the auxiliary functions.
 - .7 Mechanical connectors are not acceptable. Solder and insulate all joints if wire cannot be continuous.
 - .8 Wire with colour coded conductors.
 - .9 Supervise all wiring.
 - .10 All wiring shall have copper conductors.

- .11 Prior to energizing or commissioning the system, the F.A. system shall be fully inspected, tested, checked, and adjusted to include, but not limited to, the following:
 - .1 That the type of equipment installed is that designated by the specifications.
 - .2 That the wiring connections to all equipment components show that the installer has complied with ULC and CSA requirements.
 - .3 That the equipment has been installed in accordance with the manufacturer's recommendations and that all devices have been operated and tested to verify their operation, and that the system operates in accordance with the requirements of the Specification.
 - .4 That the supervisory wiring of those items of equipment connected to a supervisory circuit is operated as specified.
 - .5 Those Governmental regulations will be met to the satisfaction of inspection office.
- .12 The inspection and testing reports and certification of fire alarm system prepared by the fire alarm vendor shall be submitted for review by the Consultant. This work shall be complete 3 weeks prior to occupancy date.
- .13 The "dB" readings shall be provided by the fire alarm system vendor in each area/room where audible devices are installed (part of this Contract). The testing report shall be prepared and submitted for review by the Consultant. This work shall be complete 3 weeks prior to occupancy.
- .14 System changes shall be verified by the manufacturer's representative, and a verification certificate presented upon completion in accordance with CAN/ULC-S537 (Latest Edition) - Standard for Verification of Fire Alarm Systems.
- .15 Warranties all materials, installation, and workmanship for one (1) year from date of acceptance, unless otherwise specified.
- .16 System installation and operations shall be verified by the manufacturer's representative, and a verification certificate presented upon completion. The manufacturer's representative shall be responsible for an on-site demonstration of the system operation and initial staff training as required by the Owner and/or Consulting Engineer.
- .17 When the fire alarm system has been commissioned and verified it shall be fully demonstrated by this Division to the authorities having jurisdiction.

END OF SECTION

1. General

1.1 APPLICATION

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Electrical Divisions. It is intended as a supplement to each Section and is to be read accordingly.
- .2 Refer to section 26 05 01, Electrical Work General Instructions.

1.2 REFERENCES

- .1 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524 - Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S537 - Standard for Verification of Fire Alarm Systems.
 - .3 CAN/ULC-S1001-11 – Integrated Systems Testing of Fire Protection and Life Systems.
- .2 National Fire Protection Agency (NFPA)
 - .1 NFPA 72 - National Fire Alarm Code.

1.3 SUBMITTALS

- .1 Fire alarm verification report and verification certificate in accordance with CAN/ULC-S537 - Standard for Verification of Fire Alarm Systems.
- .2 Integrated systems testing of fire protection and life systems report and certificate in accordance with CAN/ULC-S1001-11 – Standard for Integrated Systems Testing of Fire Protection and Life Systems.

2. Products

- .1 Except for those items as may be specified in Part 3, of this Section, refer to Part 2 of the various Sections of Specification, Division 26 Electrical
- .2 Verify Fire Alarm System complete with all fire alarm zones in accordance with CAN/ULC-S537 (Latest Edition) - Standard for Verification of Fire Alarm Systems.
- .3 Employ and pay for the services of an independent company, (i.e.: CFMS-West, Contact: Joseph Tanel; Ph: 647-400-9872; email: joseph.tanel@cfmswest.ca, Lonergan Engineering Inc., Contact: Michael Lonergan; Ph: 416-684-2305; email: m.lonergan@lonerganeng.com, Vintage Fire and Life Safety Ltd.; Steve Salese; Ph: 519-998-8944; steve@vintagefireandlifesafety.com or Approved Equal) to inspect, test and verify the operation of the fire alarm system in accordance with CAN/ULC-S1001-11 for Integrated Systems Testing of Fire Protection and Life Systems.
- .4 Complete the installation, inspection, testing and verification of the fire alarm system as specified in Section 28 46 00, and perform "Integrated systems testing of fire protection and life systems" in accordance with CAN/ULC-S1001-11 with independent company and advise the Consultant and authority having jurisdiction in writing accordingly by providing all supporting documentation as required for CAN/ULC-S1001-11 inspection, testing and verification process three weeks prior to substantial completion of the contract.
- .5 Provide all information, drawings, documents, shop drawings, and assistance to the independent company who will be performing inspection, testing and verification of integrated system testing of fire protection and life system in accordance with CAN/ULC-S1001-11.

- .6 Coordinate with fire alarm system manufacturer, fire alarm system verification contractor and other trades and contractors for door hardware system, access control system, elevator system, mechanical systems, sprinkler and standpipe systems, building controls system, lighting control systems, security system etc. and facilitate to provide all required assistance necessary in order that the inspection, testing and verification in accordance with CAN/ULC-S1001-11 for Integrated systems testing of fire protection and life systems as specified herein can be successfully completed.
 - .7 Integrated Systems Testing of Fire Protection and Life Systems shall verify that the systems, their components including but not limited to Fire alarm systems, Sprinkler systems, Standpipe systems, Elevators, Hold-open devices, Cooking suppression system, Emergency generators, Fire pumps, Emergency Lighting systems, Electromagnetic locks, Smoke control systems, Ventilation (Pressurization) systems, Audio/Visual and/or Lighting controls, Notification systems, Water supplies, Water control valves, Freeze protection systems, Fixed fire suppression systems etc. and their interconnections with other building systems are functioning in accordance with the intent of their design.
 - .8 The independent company who will be performing inspection, testing and verification of integrated system testing of fire protection and life system in accordance with CAN/ULC-S1001-11 and acting as Integrated Testing Coordinator (ITC) shall include and perform all procedures as required by CAN/ULC-S1001-11 but not limited to:
 - .1 ITC shall develop and prepare an Integrated Testing Plan specific to the project, outlining the required tests and necessary functional results to conduct integrated fire protection and life systems testing.
 - .2 ITC shall attend construction meetings prior of integrated testing procedure; to review the integrated testing process with the architect, consultant, electrical contractor, mechanical contractor, general contractor, and owner's representative.
 - .3 ITC shall review all relevant shop drawings during construction.
 - .4 ITC shall attend site prior to day of testing to review testing process with project team/ electrical contractor and confirm all systems are ready for testing.
 - .5 ITC shall discuss with the project team/ electrical contractor, the testing process to ensure all trades are aware of their expectations on day of testing.
 - .6 ITC shall ensure that integrated testing (IT) Plan is reviewed by consultant team prior to testing.
 - .7 ITC shall ensure that all applicable system start-up reports are received prior to testing.
 - .8 ITC shall perform testing of integrated fire protection and life safety systems in accordance with CAN/ULC-S1001-11 and integrated testing plan.
 - .9 ITC shall submit an integrated testing report, specific to the project and documenting the implementation of the integrated testing plan. The report shall confirm and acceptable to the requirements of the authorities having jurisdiction.
3. Execution
- .1 Except for those items as may be specified in Part 2 of this Section refer to Part 3 of the various sections of Specification Division 26 Electrical.
 - .2 Inspect and test the fire alarm system and auxiliary equipment in accordance with CAN/ULC-S537 and integrated testing in accordance with CAN/ULC-S1001-11 as specified in Section 28 46 00 and as described above and complete and sign all necessary forms.
 - .3 Provide a letter addressed to the Consultant confirming that the fire alarm system verification and integrated testing have been satisfactorily completed.

END OF SECTION